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Superseding
NAVFAC DM-21.1
November 1984

MILITARY HANDBOOK

AIRFIELD GEOMETRIC DESIGN

AMSC N/A AREA FACR

MIL-HDBK-1021_1
NOTICE 1
31 August 1992

MILITARY HANDBOOK

TO ALL HOLDERS OF MIL-HDBK-1021/1, AIRFIELD GEOMETRIC DESIGN

1. THE FOLLOWING PAGES OF MIL-HDBK-1021/1 HAVE BEEN REVISED AND SUPERSEDE THE PAGES LISTED:

NEW PAGE	DATE	SUPERSEDED PAGE	DATE
v	31 August 1992	v	29 June 1990
vi	31 August 1992	vi	29 June 1990
65	31 August 1992	65	29 June 1990
66	31 August 1992	66	29 June 1990
67	31 August 1992	67	29 June 1990
68	31 August 1992	Reprinted without change	
69	31 August 1992	69	29 June 1990
70	31 August 1992	70	29 June 1990
95	31 August 1992	95	29 June 1990
96	31 August 1992	96	29 June 1990
97	31 August 1992	97	29 June 1990

New DD-1426 Form N/A DD-1426 Form N/A

2. RETAIN THIS NOTICE AND INSERT BEFORE TABLE OF CONTENTS.

3. Holders of MIL-HDBK-1021/1 will verify that all changes indicated above have been made. This notice page will be retained as a check sheet. This issuance, together with appended pages, is a separate publication. Each notice is to be retained by stocking points until the Military Handbook is completely revised or cancelled.

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ABSTRACT

Basic criteria regarding airfield and heliport geometric design are provided for use by experienced architects and engineers. This design criteria consists of dimensions, clearances, and grades for airfield or heliport operational areas. The contents include airfield orientation, runways, taxiways, helipads, aircraft parking aprons, and other airfield pavements.

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FOREWORD

This military handbook for airfield geometric design is one of a series developed from an extensive reevaluation of facilities in the shore establishment, from surveys of the availability of new materials and construction methods, and from selection of the best design practices of the Naval Facilities Engineering Command (NAVFACENGCOM), other Government agencies, and private industry. This handbook includes a modernization of the former criteria, and the maximum use of national professional society, association, and institute codes. Deviations from these criteria should not be made without the prior approval of the NAVFACENGCOM Headquarters (Code 04).

Design cannot remain static any more than can the naval functions it serves or the technologies it uses. Accordingly, recommendations for improvement are encouraged from within the Navy and from the private section and should be furnished on the DD Form 1426 provided inside the back cover to Commanding Officer, Southern Division, Naval Facilities Engineering command, Code 04A3, Charleston, SC 28411-0068; Telephone (803) 743-0458. MIL-HDBK-1021/1 cancels and supersedes NAVFAC DM-21.1, dated November 1984.

THIS HANDBOOK SHALL NOT BE USED AS A REFERENCE DOCUMENT FOR PROCUREMENT OF FACILITIES CONSTRUCTION. IT IS TO BE USED IN THE PURCHASE OF FACILITIES ENGINEERING STUDIES AND DESIGN (FINAL PLANS, SPECIFICATIONS, AND COST ESTIMATES). DO NOT REFERENCE IT IN MILITARY OR FEDERAL SPECIFICATIONS OR OTHER PROCUREMENT DOCUMENTS.

AIRFIELD PAVEMENT DESIGN MANUALS

Criteria Manual	Title	PA
MIL-HDBK-1021/1	Airfield Geometric Design	SOUTHDIV
MIL-HDBK-1021/2	General Concepts for Pavement Design	WESTDIV
DM-21.03	Flexible Pavement Design for Airfields	U.S. Army
MIL-HDBK-1021/4	Rigid Pavement Design for Airfields	WESTDIV
MIL-HDBK-1021/5	Soil Stabilization for Pavement	SOUTHDIV
DM-21.06	Airfield Pavement Design for Frost Conditions and Subsurface Drainage	WESTDIV
MIL-HDBK-1021/7	Airfield Pavement Evaluation	HDQTRS
DM-21.9	Skid Resistant Runway Surfaces	HDQTRS

AIRFIELD GEOMETRIC DESIGN

CONTENTS

FIGURES

TABLES

FACILITY PLATES

Section 1: INTRODUCTION

1.1 Scope. This section includes general information and factors to be considered in the orientation of runways. Aircraft pavement criteria, including aircraft facilities, structural design of rigid and flexible pavements, drainage, design for frost action, evaluation of existing pavements, marking of airfield pavements, and hazards to air navigation are covered in succeeding design manuals in the DM-21 Series, Airfield Pavement Design. For definitions and specialized terminology used in this manual, see Glossary.

1.2 Cancellation. This publication, MIL-HDBK-1021/1, Airfield Geometric Design, cancels and supersedes NAVFAC DM-21.1, November 1984, Definitive Drawings DD-1291774/1776, and incorporates criteria published in the Joint Service Manual NAVFAC P-971, Airfield and Heliport Planning Criteria.

1.3 Related Criteria. Additional criteria related to Navy airfield types and missions, airfield locations, air and space requirements, and runway and taxiway system configurations may be found in NAVFAC P-80, Facility Planning Factor Criteria for Navy and Marine Corps Shore Installations; NAVFAC P-80.3, Airfield Safety Clearances, and NAVFAC P-970, Planning in the Noise Environment.

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Section 2: RUNWAY FACTORS

2.1 Airfield Types and Missions. Navy and Marine Corps airfields are classified by mission as air stations, air facilities, auxiliary landing fields, or outlying fields. Airfield layout is determined by the mission and number and types of supported activities. Airfields also may be categorized by the types of aircraft for which facilities are provided.

2.1.1 Air Stations. Naval Air Stations (NAS) and Marine Corps Air Stations (MCAS) may be fleet support air stations; training command air stations; research, development, test, and special air stations; or overseas air stations.

2.1.2 Master Jet Air Station. The parent NAS or MCAS within a regional fleet support command which has under its operational control a minimum of two satellite installations for such activities as instrument training, fleet carrier landing practice, and ordnance training.

2.1.3 Air Facilities. Naval Air Facilities (NAF) and Marine Corps Air Facilities (MCAF) may be for fleet support or for some special requirement such as Marine Corps rotary-wing observation and transport aircraft or support of research, development, test, and special missions.

2.1.4 Other Air Installations.

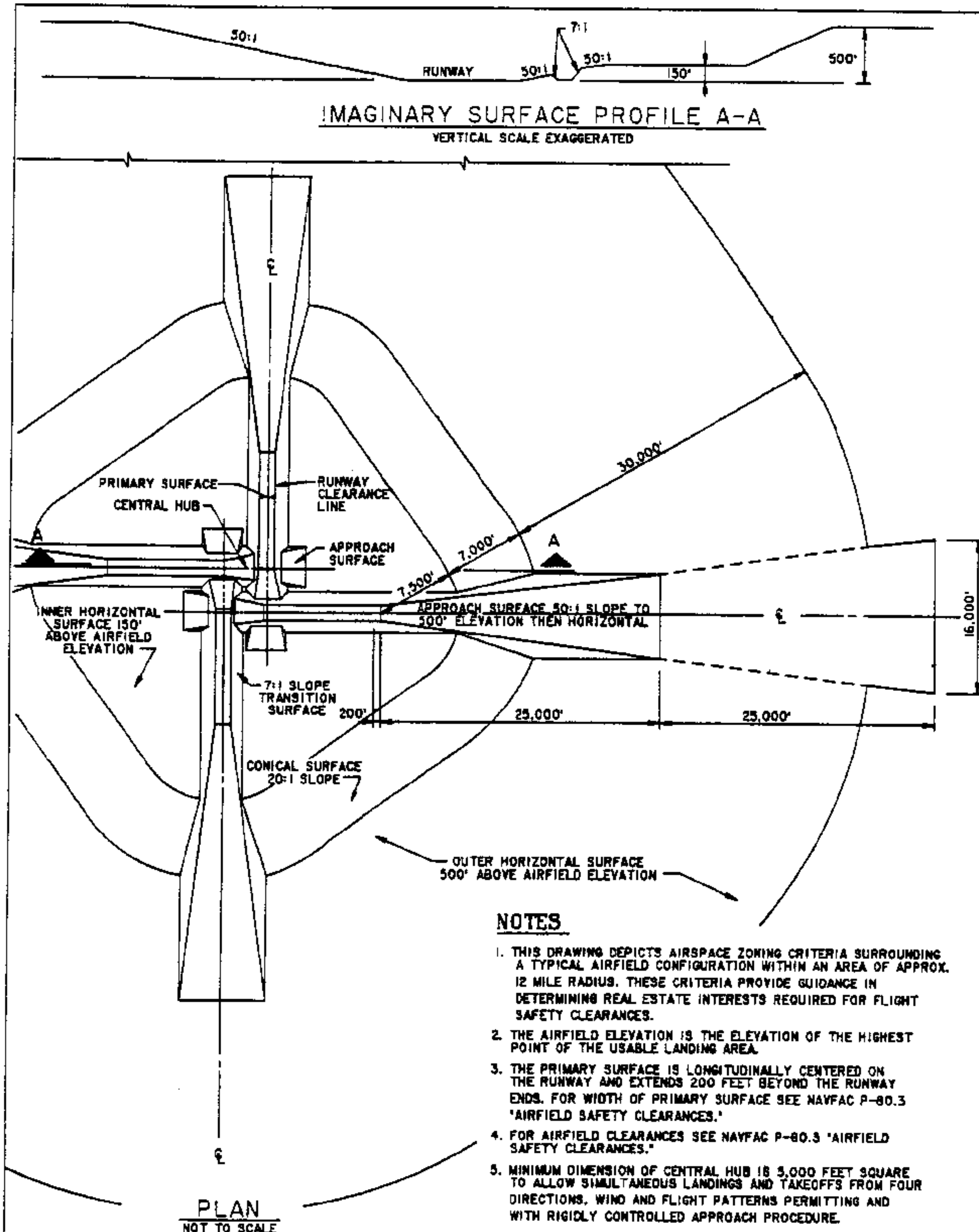
a) Auxiliary landing fields may be either Navy (NALFs) or Marine Corps (MCALFs), and provide only minimum support.

b) Outlying fields, either Navy (NOLFs) or Marine Corps (MCOLFs), generally provide only a landing area.

2.2 Land and Airspace Requirements. See NAVFAC P-80 and NAVFAC P-80.3 and Facility Plate No. 110. The space required for airfields includes the land area required for runways, taxiways, aprons, and other station facilities, as well as the adjacent airspace required for the safe arrival and departure of aircraft. Typical airspace zoning requirements are shown for quadrantal, triangular, and parallel-perpendicular runway configurations in the five facility plates comprising Facility Plate No. 110. Airfield layout considerations include runway orientation, mission requirements, ultimate development, local terrain, expected type and volume of air traffic, restrictions due to obstacles or surrounding community, traffic patterns such as the arrangement of multidirectional approaches and takeoffs, noise impact, and aircraft accident potential.

2.3 Airfield Traffic. A single runway accommodates a fixed maximum number of Instrument Flight Rule (IFR) movements per hour; however, a different maximum capability exists for Visual Flight Rule (VFR) operations. These maximums are directly related to the type of aircraft using the airfield, mix of different types, mission, runway length, number and location of runway exits, taxiways, and other factors. Provision of dual runways or simultaneously usable runway systems may be indicated as a result of a detailed traffic capacity study.

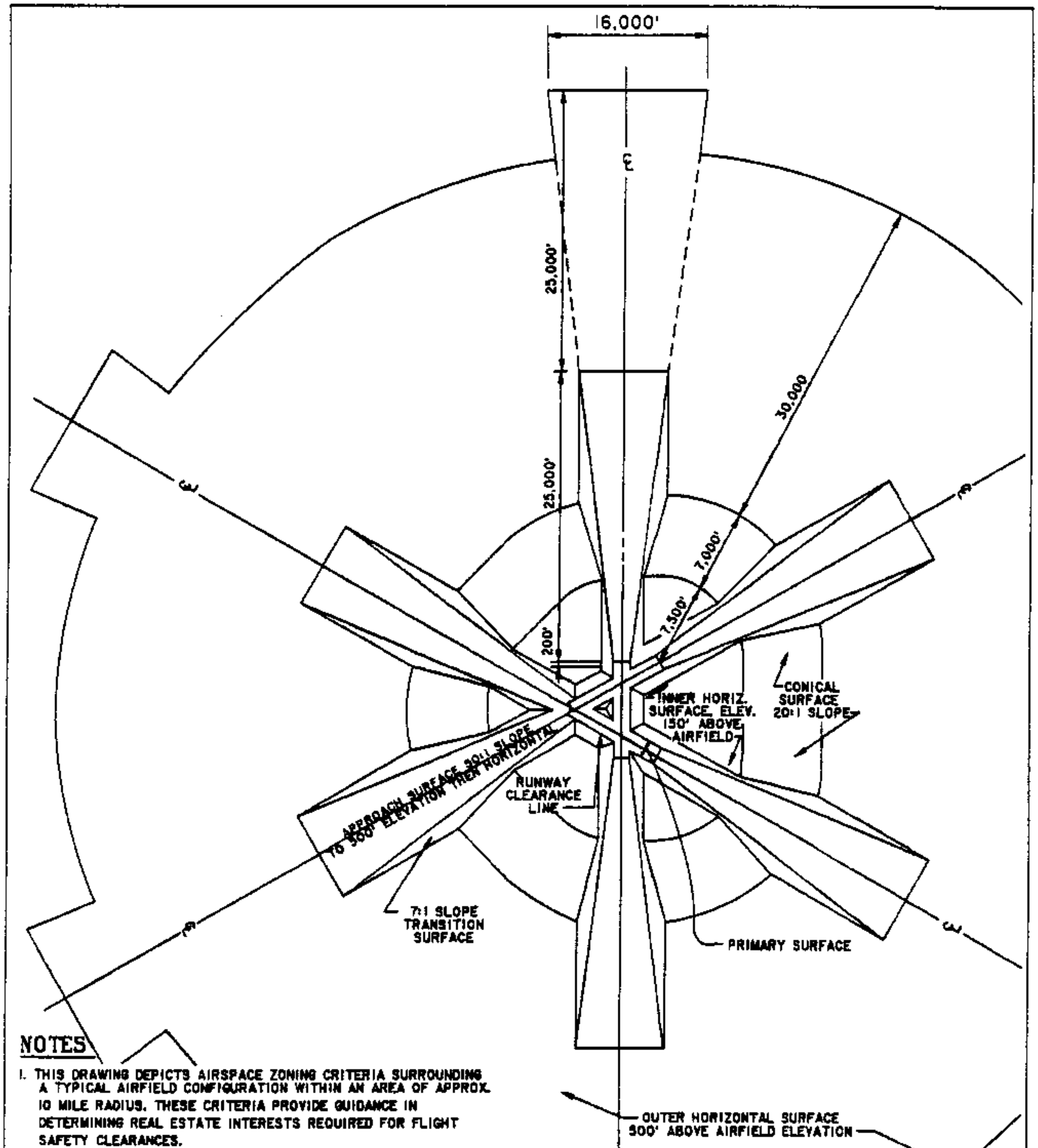
2.4 Runway Systems. The choice among the various runway systems and configurations which may be used is governed by such factors as mission requirements, possible ultimate developments, local terrain conditions, and



NOTES

1. THIS DRAWING DEPICTS AIRSPACE ZONING CRITERIA SURROUNDING A TYPICAL AIRFIELD CONFIGURATION WITHIN AN AREA OF APPROX. 12 MILE RADIUS. THESE CRITERIA PROVIDE GUIDANCE IN DETERMINING REAL ESTATE INTERESTS REQUIRED FOR FLIGHT SAFETY CLEARANCES.
2. THE AIRFIELD ELEVATION IS THE ELEVATION OF THE HIGHEST POINT OF THE USABLE LANDING AREA.
3. THE PRIMARY SURFACE IS LONGITUDINALLY CENTERED ON THE RUNWAY AND EXTENDS 200 FEET BEYOND THE RUNWAY ENDS. FOR WIDTH OF PRIMARY SURFACE SEE NAVFAC P-80.3 "AIRFIELD SAFETY CLEARANCES."
4. FOR AIRFIELD CLEARANCES SEE NAVFAC P-80.3 "AIRFIELD SAFETY CLEARANCES."
5. MINIMUM DIMENSION OF CENTRAL HUB IS 5,000 FEET SQUARE TO ALLOW SIMULTANEOUS LANDINGS AND TAKEOFFS FROM FOUR DIRECTIONS, WIND AND FLIGHT PATTERNS PERMITTING AND WITH RIGIDLY CONTROLLED APPROACH PROCEDURE.

TITLE	DATE	FACILITY PLATE NO.	SHEET
Airspace Zoning Quadrantal Airfield Configuration	5/87	110	1 of 5



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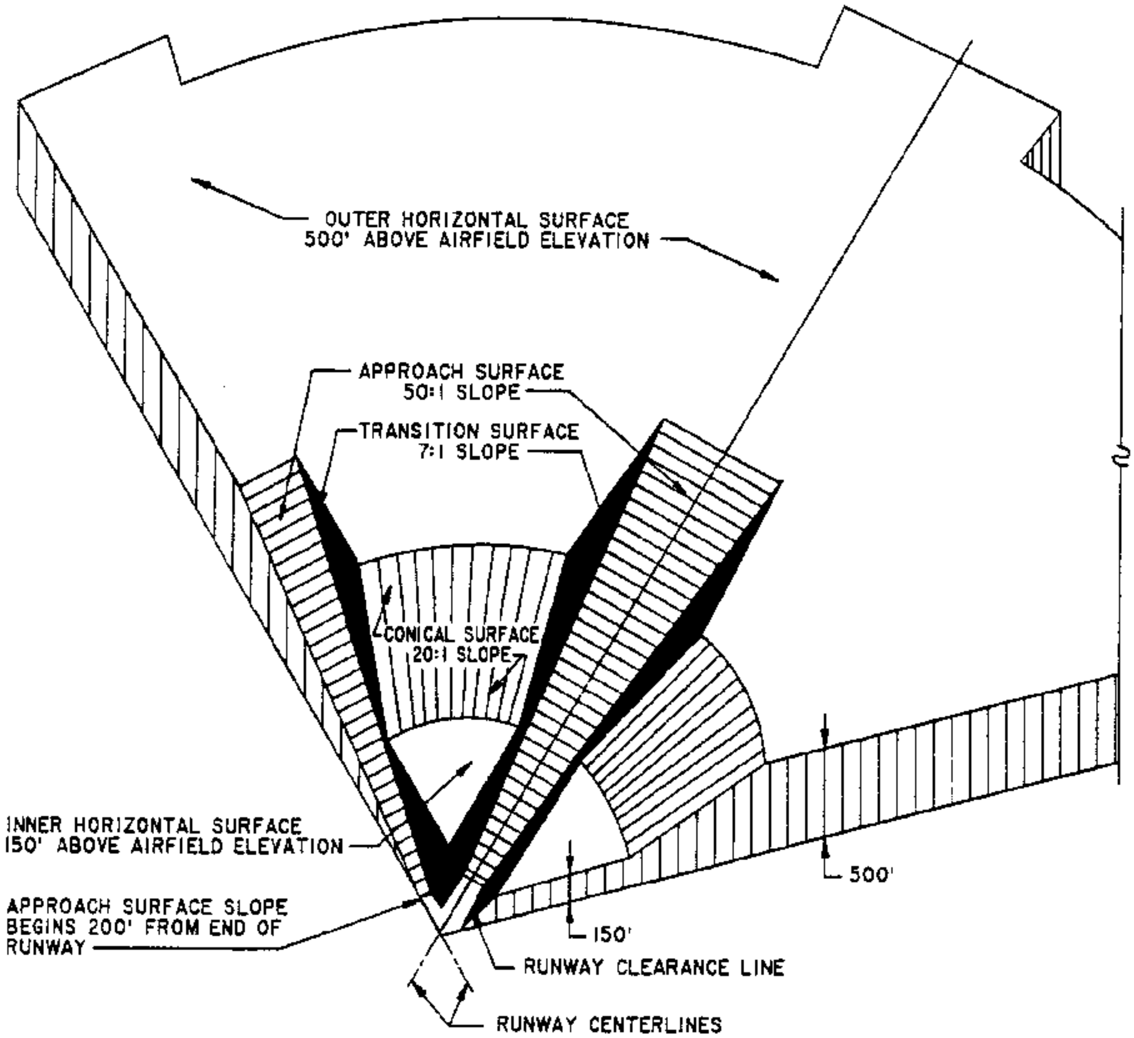
1. THIS DRAWING DEPICTS AIRSPACE ZONING CRITERIA SURROUNDING A TYPICAL AIRFIELD CONFIGURATION WITHIN AN AREA OF APPROX. 10 MILE RADIUS. THESE CRITERIA PROVIDE GUIDANCE IN DETERMINING REAL ESTATE INTERESTS REQUIRED FOR FLIGHT SAFETY CLEARANCES.
2. THE AIRFIELD ELEVATION IS THE ELEVATION OF THE HIGHEST POINT OF THE USABLE LANDING AREA.
3. THE PRIMARY SURFACE IS LONGITUDINALLY CENTERED ON THE RUNWAY AND EXTENDS 200 FEET BEYOND THE RUNWAY ENDS. FOR WIDTH OF PRIMARY SURFACE SEE NAVFAC P-80.3 'AIRFIELD SAFETY CLEARANCES.'
4. FOR AIRFIELD CLEARANCES SEE NAVFAC P-80.3 'AIRFIELD SAFETY CLEARANCES.'

PLAN
NOT TO SCALE

TITLE	DATE	FACILITY PLATE NO.	SHEET
Airspace Zoning Triangular Airfield Configuration	5/87	110	2 of 5



AIRSPACE IMAGINARY SURFACES

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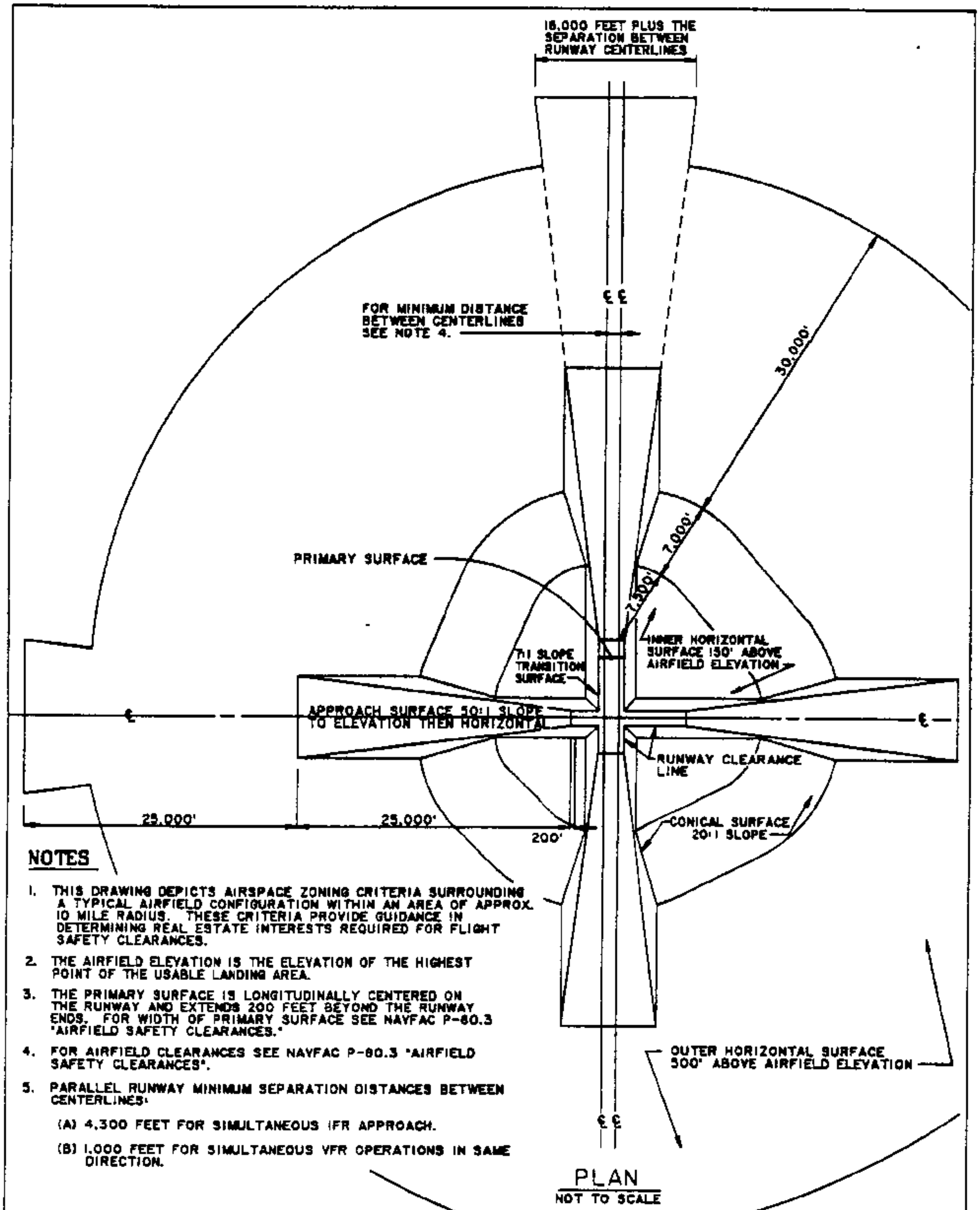
TITLE	Airspace Zoning Triangular Airfield Configuration	DATE 5/87	FACILITY PLATE NO. 110	SHEET 3 of 5



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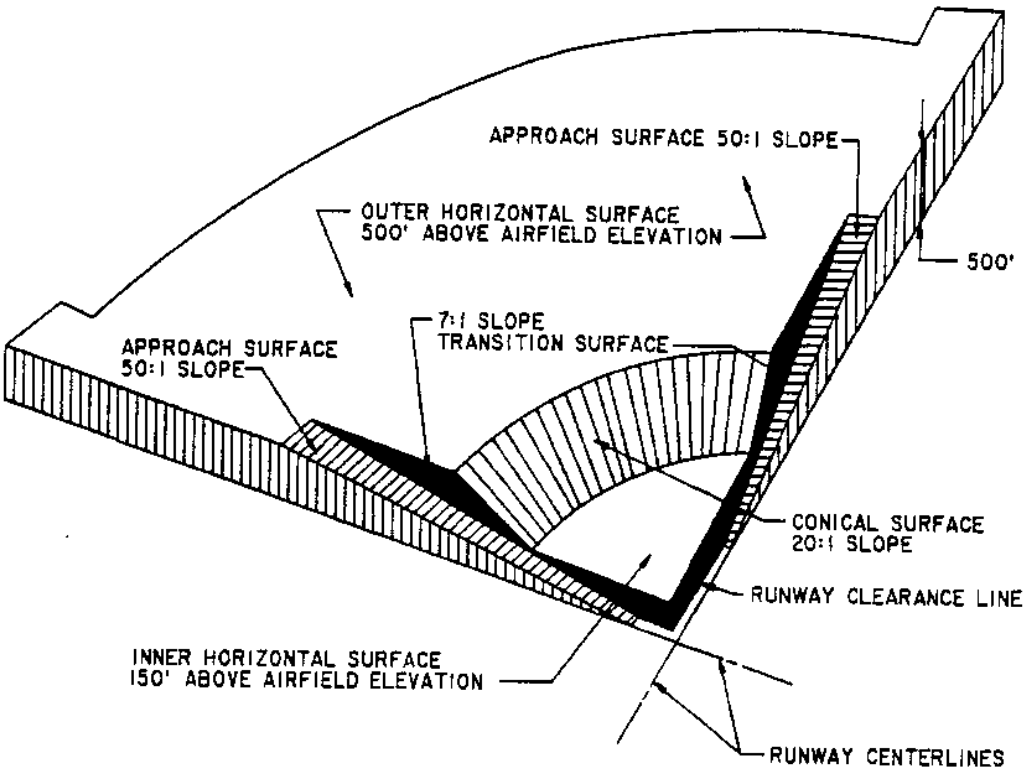
2. THE AIRFIELD ELEVATION IS THE ELEVATION OF THE HIGHEST POINT OF THE USABLE LANDING AREA.
3. THE PRIMARY SURFACE IS LONGITUDINALLY CENTERED ON THE RUNWAY AND EXTENDS 200 FEET BEYOND THE RUNWAY ENDS. FOR WIDTH OF PRIMARY SURFACE SEE NAVFAC P-80.3 "AIRFIELD SAFETY CLEARANCES."
4. FOR AIRFIELD CLEARANCES SEE NAVFAC P-80.3 "AIRFIELD SAFETY CLEARANCES".
5. PARALLEL RUNWAY MINIMUM SEPARATION DISTANCES BETWEEN CENTERLINES:
   (A) 4,300 FEET FOR SIMULTANEOUS IFR APPROACH.
   (B) 1,000 FEET FOR SIMULTANEOUS VFR OPERATIONS IN SAME DIRECTION.

TITLE	DATE	FACILITY PLATE NO.	SHEET
Airspace Zoning Parallel-Perpendicular Airfield Configuration	5/87	110	4 of 5



AIRSPACE IMAGINARY SURFACES

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TITLE	DATE	FACILITY PLATE NO.	SHEET
Airspace Zoning Parallel-Perpendicular Airfield Configuration	5/87	110	5 of 5

orientation required by local wind conditions. Typical layouts of single and dual runway systems, dimensions, lateral clearances, and separation criteria are shown in Section 4. The principal runway systems are as follows:

2.4.1 Single Runway. A single runway is the least flexible and lowest capacity system. The capacity of a single runway system will vary from approximately 40 to 50 operations per hour under IFR conditions and up to 75 operations per hour under VFR conditions.

2.4.2 Parallel Runways. Parallel runways are the most commonly used systems for increased capacity. In some cases parallel runways may be staggered with the runway lengths overlapping and with terminal or service facilities located between the runways. When parallel runways are closely spaced the capacity under VFR conditions is increased but not under IFR conditions.

2.4.3 Triangular Runways. Triangular runways may be either the open-V or the intersecting type of runway. The triangular system is adaptable to a wider variation of wind conditions than the parallel system. When winds are mild both runways may be used simultaneously. An open-V system will have a greater capacity than the intersecting system.

2.5 Runway Classification. Table 1 classifies Class A and Class B runways by aircraft type. Class A runways are primarily intended for small light aircraft and do not have the potential for development to heavy aircraft use or for which no foreseeable requirement for such use exists. Ordinarily, less than 10 percent of runway operations involve aircraft in the Class B category, and the runways are less than 8000 feet long. Class B runways are all other fixed-wing runways.

TABLE 1
Runway Classification by Aircraft Type [1]

Class A Runways		Class B Runways		
C-1	O-2	A-3	C-121	F-100
C-2	OV-1	A-4	C-123	F-101
C-4	OV-10	A-5	C-130	F-104
C-6	S-2	A-6	C-131	F-105
C-7	T-28	A-7	C-135	F-106
C-12	T-34	A-8	C-137	F-lll
C-45	T-41	A-10	C-14O	P-2
C-47	T-42	A-18	C-141	P-3
C-117	T-44	AV-8	E-3	S-3
E-l	U-10	B-1	E-4	SR-71
E-2	U-11	B-52	F-4	T-2
O-1	U-21	B-57	F-5	T-29
	UV-18	C-5	F-8	T-33
	V-22	C-9	F-14	T-37
		C-10	F-15	T-38
		C-14	F-16	T-39
		C-15	F-17	TR-1
		C-118	F-18	U-2

[1] Only symbols for basic mission aircraft or basic mission aircraft plus type are used. Designations represent entire series. Runway classes in this table are not related to aircraft approach categories.

Section 3: WIND COVERAGE STUDIES

3.1 Basic Considerations. Establish tentative runway orientations by a wind coverage study. Adjust tentative orientation for maximum construction economy and for ease of future expansion, but comply with operation runway orientation requirements.

3.1.1 Meteorological Conditions. Determine average weather conditions for at least the last 5 years. Ascertain frequency of occurrence, singly and in combination, for: wind (direction and velocity), temperature, humidity, barometric pressure, clouds (type and amount), visibility (ceiling), precipitation (type and amount), thunderstorms, and any other unusual weather conditions peculiar to the area.

a) Usable Data. Use only data which give representative average values. For example, do not consider extremes of wind velocity during infrequent thunderstorms of short duration.

b) Source of Data. Obtain meteorological data from one or more of the following sources:

(1) National Weather Service

(2) Bureau of Reclamation

(3) U.S. Forest Service

(4) Soil Conservation Service

(5) Federal Aviation Administration

(6) U.S. Army Corps of Engineers

(7) Navy Oceanographic Office

(8) U.S. Geological Survey

3.1.2 Wind Velocity and Direction. The following are the most important meteorological factors determining runway orientation:

a) Composite Wind Rose. When weather recording stations are located near a proposed site and intervening terrain is level or slightly rolling, prepare a composite wind rose from data of surrounding stations.

b) Terrain. If intervening terrain is mountainous or contains lakes or large rivers, allow for their effects on wind velocities and directions by judgment, after study of topographical information and available meteorological data.

c) Additional Weather Data. Consider wind directions and velocities in conjunction with visibility, precipitation, and other pertinent weather information.

d) Wind Distribution. Determine wind distribution to accompany instrument flight rule (IFR) conditions when considering orientation of an instrument runway.

3.1.3 Use of Wind Rose Diagrams. For a typical wind rose diagram (relative frequency and average strength of winds from different directions), components, and supporting data, see Figure 1. Prepare a wind rose diagram for each new runway in the planning stage.

a) Special Conditions. Wind rose diagrams for special meteorological conditions, such as wind velocities and directions during IFR conditions, should be prepared when necessary for local airfield needs.

(1) Wind Direction. Use radial lines to represent compass directions based on true north, and concentric circles, drawn to scale, to represent wind velocities measured from the center of the circle.

(2) Calm Wind. Use the innermost circle to encompass calm periods and wind velocities up to the allowable crosswind component for the airfield under consideration (15 knots or 17.3 miles per hour on Figure 1).

(3) Computations. Compute percentages of time that winds of indicated velocities and directions occur, and insert them in the segments bounded by the appropriate radial direction lines and concentric wind velocity circles. Express percentages to the nearest tenth, which is adequate and consistent with wind data accuracy.

b) Desired Runway Orientation. For the use of wind rose diagrams in determining desirable runway orientations with respect to wind coverage, see Figure 2.

3.2 Wind Coverage Requirements for Runways. Place runways to obtain at least 95 percent wind coverage.

3.2.1 Primary Runways. Orient a primary runway for the maximum possible wind coverage. See Figure 2 for the method of determining wind coverage.

3.2.2 Secondary Runways. Where wind coverage of the primary runway is less than 95 percent or in the case in some localities where during periods of restricted visibility the wind is from a direction other than the direction of the primary runway, a secondary (crosswind) runway is required. Normally secondary runways will not be planned without prior authorization from Naval Air Systems Command. The secondary runway will be oriented so that the angle between the primary and secondary runway longitudinal centerline is as near 90 degrees as is feasible considering local site conditions and the need to provide maximum crosswind coverage.

3.2.3 Maximum Allowable Crosswind Components. Select these components according to type of aircraft, as follows: (1) tricycle gear aircraft, 15.0 knots, and (2) conventional gear aircraft, 10.4 knots.

3.2.4 Allowable Variations of Wind Direction. See Figure 3 for allowable wind directions.

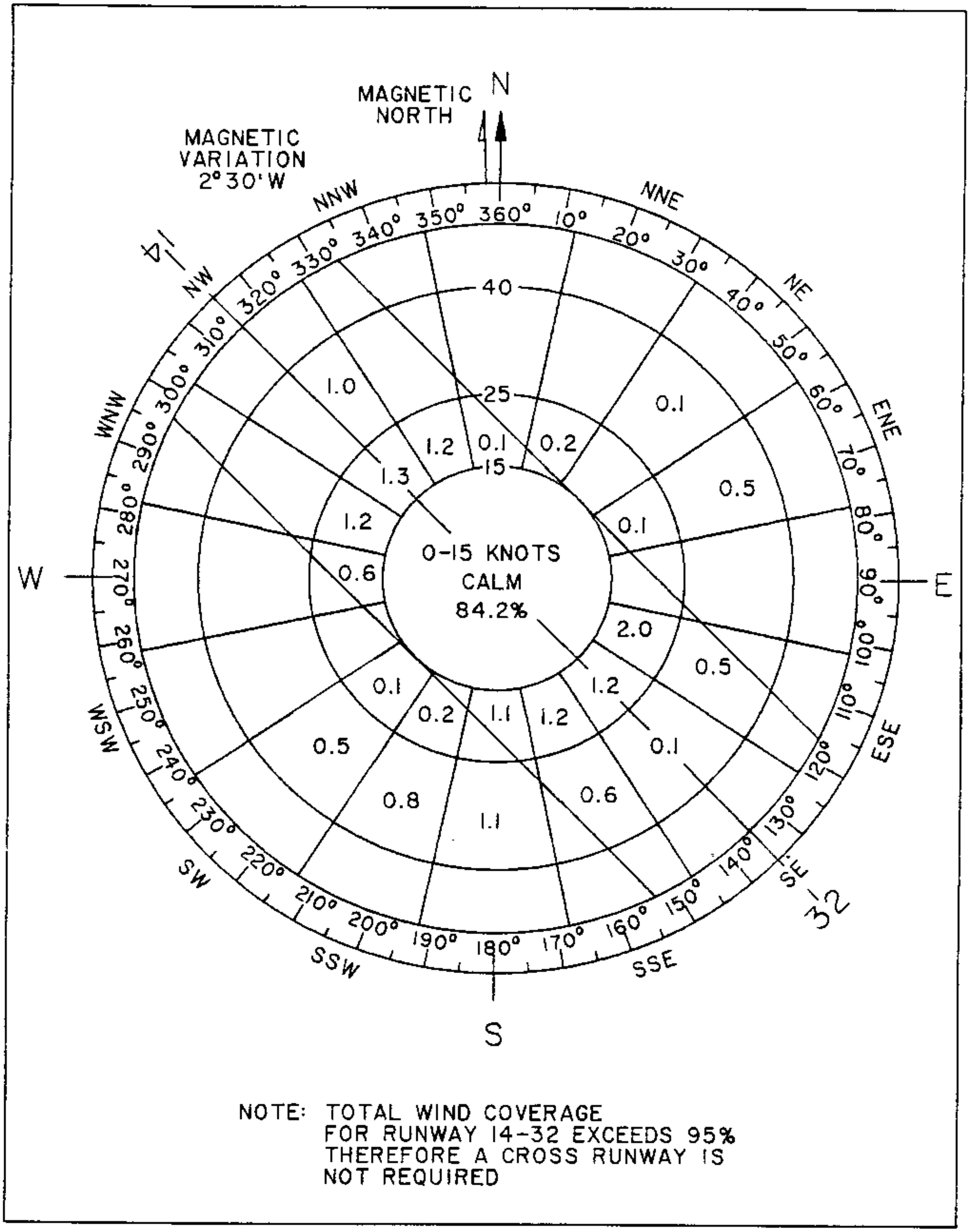
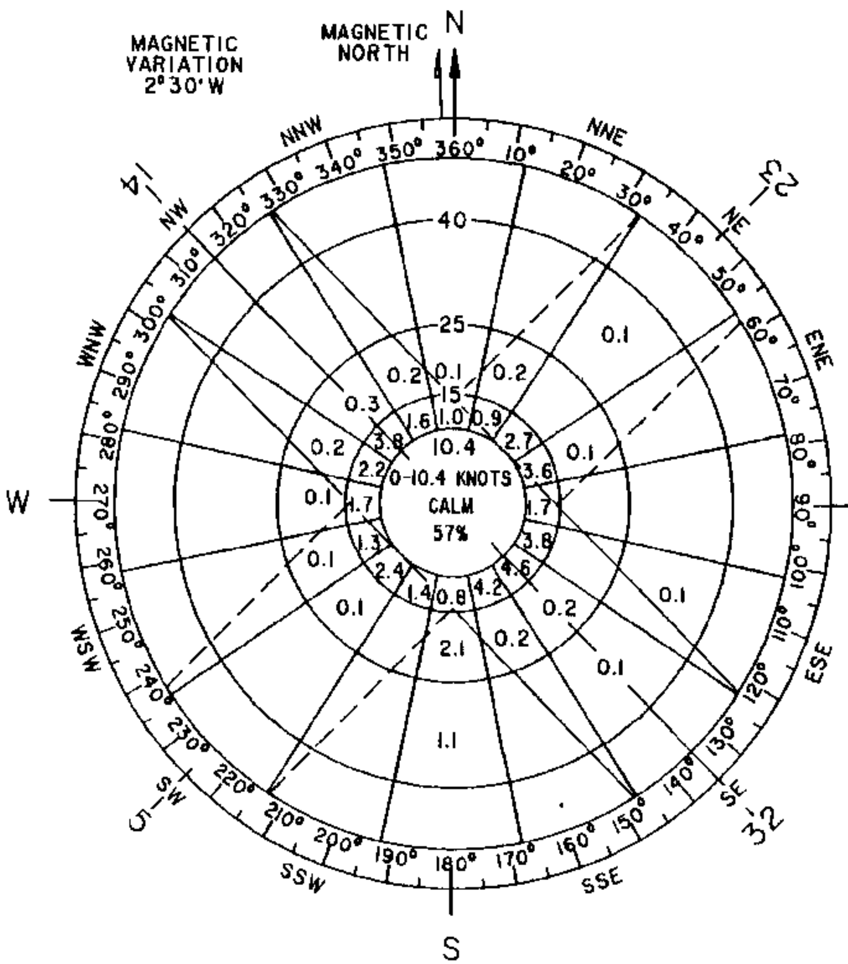


Figure 1
Wind Rose (15-Knot Crosswind Component)



10.4-KNOT CROSSWIND COMPONENT WIND ROSE

RUNWAY OR COMBINATION	WIND COVERAGE TABULATION					PERCENT COVERED
	PERCENT COVERED					
	0 TO 10.4 KNOTS	10.4 TO 15 KNOTS	15 TO 25 KNOTS	25 TO 40 KNOTS	40 & OVER KNOTS	
14-32	57.0	26.0	1.1	0.1	—	84.2
5-23	57.0	18.4	0.5	0.1	—	76.0
14-32 5-23	57.0	37.7	1.6	0.2	—	96.5

PROCEDURE

TO DETERMINE DESIRABLE RUNWAY DIRECTIONS AN OVERLAY CONSISTING OF THREE PARALLEL LINES IS USED ON THE WIND ROSE. THE DIRECTION BETWEEN THE TWO OUTER LINES OF THE OVERLAY IS EQUAL TO THE DIAMETER OF THE INNERMOST CIRCLE OF THE WIND ROSE. THE THIRD LINE IS THE CENTERLINE AND REPRESENTS THE RUNWAY CENTERLINE.

PLACE CENTERLINE OF OVERLAY ACROSS CENTER OF WIND ROSE AND ROTATE UNTIL SUM OF PERCENTAGE APPEARING BETWEEN OUTER TWO LINES, INCLUDING FRACTIONAL PORTIONS OF SEGMENTS, BECOMES A MAXIMUM. IN THIS EXAMPLE A SINGLE RUNWAY DIRECTION (SOLID OVERLAY LINES) PROVIDES ONLY A MAXIMUM OF 84.2% WIND COVERAGE. SINCE THE TOTAL WIND COVERAGE IS LESS THAN THE 95% REQUIRED FOR AN AIRFIELD, A SECONDARY OR CROSSWIND RUNWAY IS REQUIRED.

PLACE OVERLAY (DASHED LINES) TO FORM THE PERFERED 90° ANGLE WITH PRIMARY RUNWAY, 60° IS THE MINIMUM ALLOWABLE, AND TOTAL THE WIND COVERAGE PROVIDED BY BOTH RUNWAYS WHICH IS 96.5%.

ABOVE EXAMPLE USES THE WIND ROSE WITH CROSSWIND COMPONENT OF 10.4 KNOTS WHICH IS CRITICAL FOR AIRFIELDS WITH CONVENTIONAL GEAR AIRCRAFT OPERATIONS. USING WIND ROSE WITH 15 KNOT CROSSWIND COMPONENT, SEE FIGURE 1-1 WHICH IS THE ALLOWABLE FOR AIRCRAFT WITH TRICYCLE GEAR.

Figure 2
Determination Of Runway Direction Using Wind Rose

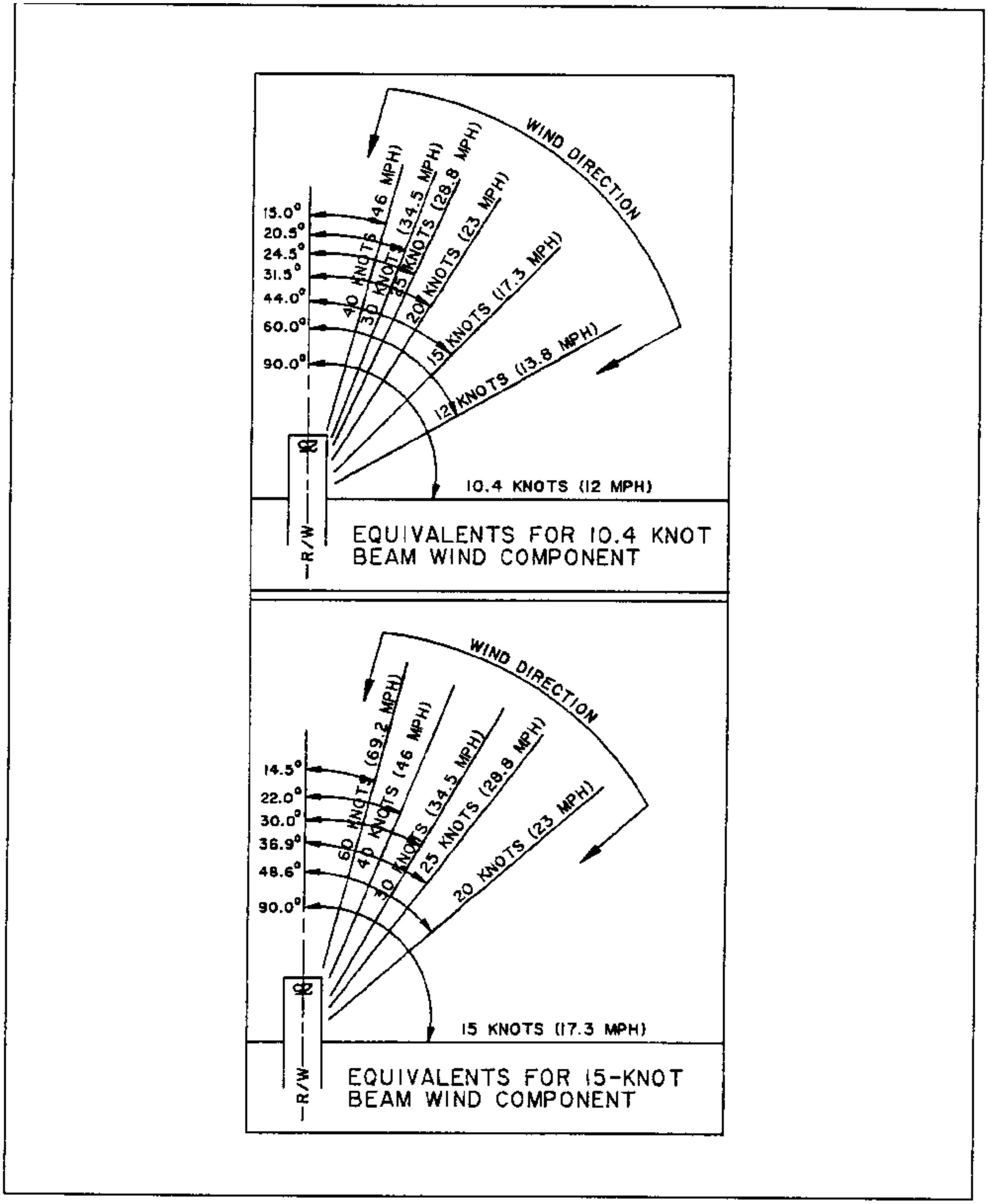


Figure 3
Allowable Wind Variations For 10.4 And 15-Knot Beam Wind Components

3.3 Additional Considerations. In addition to meteorological and wind conditions, the following factors must be considered:

3.3.1 Obstructions. A specific airport site and the proposed runway orientation must be known before a detailed survey can be made of obstructions which affect aircraft operations. Runways should be so oriented that approaches necessary for the ultimate development of the airfield are free of all obstructions.

3.3.2 Restricted Areas. Restricted areas are shown on sectional and local aeronautical charts. Runways should be so oriented that their approach and departure patterns do not encroach on the restricted areas.

3.3.3 Built-Up Areas. Airfield sites and runway alignment should be selected and the operational procedures adopted which will be the least objectionable to local inhabitants. See OPNAVINST 11010.36, Air Installations Compatible Use Zone (AICUZ) Program, for guidance.

3.3.4 Neighboring Airports. Existing and potential holding and other traffic patterns of airfields in the area should be studied, and adequate separation between these patterns should be provided to avoid air traffic conflicts.

3.3.5 Topography. Avoid sites which require excessive cuts and fills. Evaluate the effects of topographical features on: airspace zoning, grading, drainage, and possible future runway extensions.

3.3.6 Soil Conditions. Evaluate soil conditions at potential sites to minimize settlement problems, heaving from highly expansive soils, high ground water problems, and construction costs.

Section 4. RUNWAYS

4.1 Design Criteria. This section contains design criteria for both fixed- and rotary-wing aircraft runways, including procedures for orientation and for runway length determination. In addition, criteria are provided for design of the surfaces of the runway shoulders, overrun area, stabilized area, blast protective pavement, and clear zone. See Table 2 for lateral runway clearance criteria.

The number of runways required at an airfield, and their geometry, are determined from analysis of wind coverage, expected traffic density, aircraft type, mission, local development planning, terrain evaluation, and other pertinent factors.

4.2 Design Requirements. Design includes the layout, grading, and drainage of the runway or runways, the dimensions and strength of the runway pavement and shoulders, and the requirements of other areas such as the overrun and intermediate area, blast protective pavement, and the clear zone.

4.2.1 Layout. Runway layout includes selection of runway system, orientation of principal and crosswind runways, and the lateral clearances which are required.

4.2.1.1 Runway Orientation. The runway shall be aligned based on analysis of the wind data, terrain, local development, operational procedures, and other pertinent factors (see Section 2). Data for wind analysis may be obtained through the Navy Oceanographic Office.

4.2.1.2 Runway Lateral Clearances. The minimum separation distance from the runway centerline to the runway clearance line shall be 500 feet for Class A runway; 1000 feet for Class B runway (runways at air stations established before June 1981 may be 750 feet, see NAVFAC P-80.3), and to the taxiway centerline, 500 feet. The runway clearance line is the lateral limit of the primary surface and the beginning of the transition surface (7:1 side slope) as shown in Figures 4, 5, and 6. For basic training outlying fields, propeller aircraft, the minimum separation distance from the runway centerline to the runway clearance line shall be 500 feet, and the transition surface slopes upward at 2:1 for T-34 aircraft and 7:1 for all others from the runway clearance line to an elevation of 150 feet. Minimum distance between centerlines of parallel runways used for simultaneous takeoffs or landings in the same direction shall be 1000 feet for VFR and 4300 feet for IFR operations. See Table 2 for additional lateral clearance criteria. Typical runway, taxiway, and primary surface transverse sections are in Figure 6.

4.3 Runway Length. Compute length of runway as prescribed in NAVFAC P-80.

4.3.1 Corrections. The basic runway length, determined by aircraft characteristics, shall be corrected for nonstandard conditions of altitude and temperature and for runway gradient, if appropriate, and a safety factor shall be used to account for indeterminate corrections.

TABLE 2
Runway Pavement Criteria

Item	Criteria
Strength and type of pavement	MIL-HDBK-1021/2/4 and NAVFAC DM-21.3.
Smoothness	Maximum irregularity shall be: Rigid Pavement + 1/8 inch in 10 feet. Flexible Pavement + 1/4 inch in 10 feet.
Length	For computation of runway lengths, see NAVFAC P-80.
Width:	
Class A Runway	75 feet minimum - 200 feet maximum, see NAVFAC P-80.
Class B Runway	200 feet.
Maximum longitudinal grades:	
Class A and B Runways	1%. Hold to minimum practical. 0.8% in first and last 3000 feet.
Longitudinal grade changes:	
Class A and B Runways	Maximum allowable grade change at a vertical point of intersection (PI) is 1.5%. Maximum allowable rate of grade change is 0.10% per 100 lineal feet of runway for new construction. Exception: 0.167% for thin overlays on existing construction prior to 1989. Exception: 0.3% at basic training outlying fields. Exception: 0.4% for edge of runways at runway intersections. Maximum rate of longitudinal grade change is produced by vertical curves having 1000 foot lengths for each percent of algebraic difference between the two grades. Where more than one grade change occurs, the distance between two successive points of intersection (PIs) will be no less than 1000 feet and two successive distances between PIs will not be the same.

TABLE 2 (Continued)
Runway Pavement Criteria

Item	Criteria
Class A Runway	No grade change is to occur within 1000 feet of the runway end.
Class B Runway	No grade change is to occur within 3000 feet of the runway end.
Sight distance:	
Class A Runway	3000 feet minimum. Any two points 5 feet above the pavement must be mutually visible for the distance indicated.
Class B Runway	5000 feet minimum. Any two points 8 feet above the pavement must be mutually visible for the distance indicated.
Transverse grades:	
Class A and B Runways	From centerline of runways. 1.0% minimum, 1.5% maximum. Selected slope is to remain constant for length of runway, except at runway intersections where pavement surfaces must be warped.
Fillets at intersections of runways	Minimum radius same as at intersection of taxiways and runways. See Figure 22.
Runway marking	See NAVAIR 51-50AAA-2.
Elevation differences	Maximum: 5 feet between crowns of parallel runways; 10 feet between crowns of runway and parallel taxiway.
Runway lateral clearance distance (Primary surface):	
Class A Runway	500 feet.

TABLE 2 (Continued)
Runway Pavement Criteria

Item	Criteria
Class B Runway	1000 feet. Measured perpendicularly from centerline of runway. This distance is to be clear of fixed and mobile obstacles. Where the lateral clearance distance has been established according to the previous 750 foot criteria the 750 foot distance may remain. See NAVFAC P-80.3. For new runway construction at existing air installations NAVFAC Headquarters should be consulted for criteria.
Runway lateral clearance distance (Primary surface) (Continued)	In addition to the lateral clearance criteria, the vertical height restriction on structures and parked aircraft as a result of the 7:1 transitional slope must be taken into account. (1) Fixed obstacles include manmade or natural features such as buildings, trees, rocks, terrain irregularities and any other features constituting possible hazards to moving aircraft. Siting exceptions for frangibly mounted air navigational aids and meteorological facilities are in NAVFAC P-80. (2) Mobile obstacles include parked aircraft, parked and moving vehicles, railroad cars, and similar equipment. Taxiing aircraft and emergency vehicles are exempt from this restriction. (3) Parallel taxiways for Navy and Marine Corps airfields may be located within the lateral clearance distance at least 500 feet from centerline of runway to centerline of taxiway. (4) Aboveground drainage structures are not allowed but may be individually reviewed. Drainage slopes of up to a 10:1 ratio are permitted for all runway classes, but swales with more gentle slopes are preferred.

TABLE 2 (Continued)
Runway Pavement Criteria

Item	Criteria
Longitudinal grades within primary surface:	
Class A and B Runways	10.0% maximum. Exclusive of pavement, shoulders, and cover over drainage structures. Slopes are to be gradual as practicable. Avoid abrupt changes or sudden reversals. Rough grade to the extent necessary to prevent damage to aircraft in the event of erratic performances.
Transverse grades within primary surface:	
Class A and B Runways	2.0% minimum prior to channelization. 10.0% maximum. Additional requirements same as given for the longitudinal grades within primary surface.
Distance between centerlines of parallel runways:	
Class A Runway	Not applicable.
Class B Runway	1000 feet VFR 4300 feet IFR using simultaneous approaches.

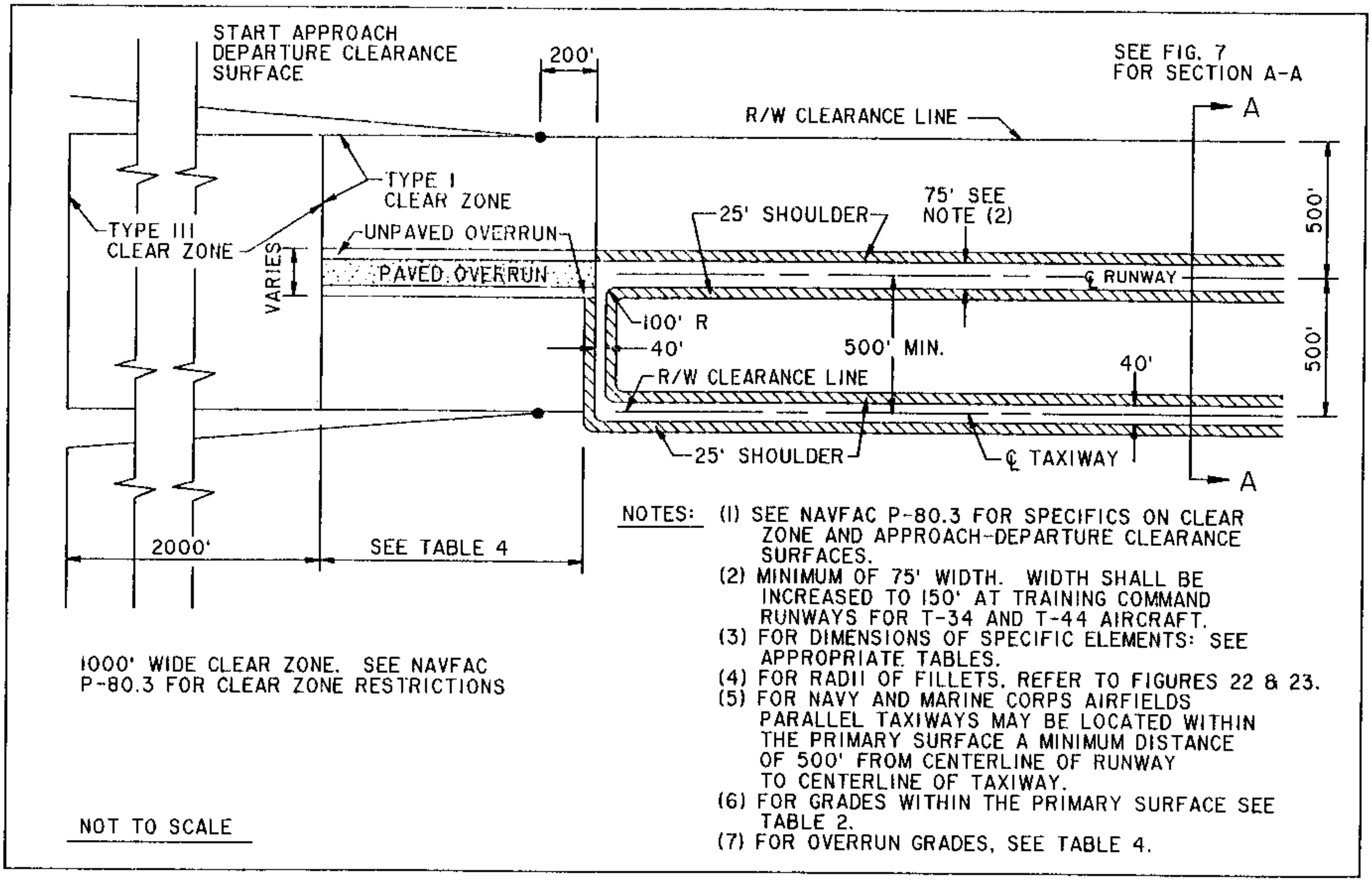


Figure 4
Plan - Single Runway
Class A Runway And Basic Training Outlying Field

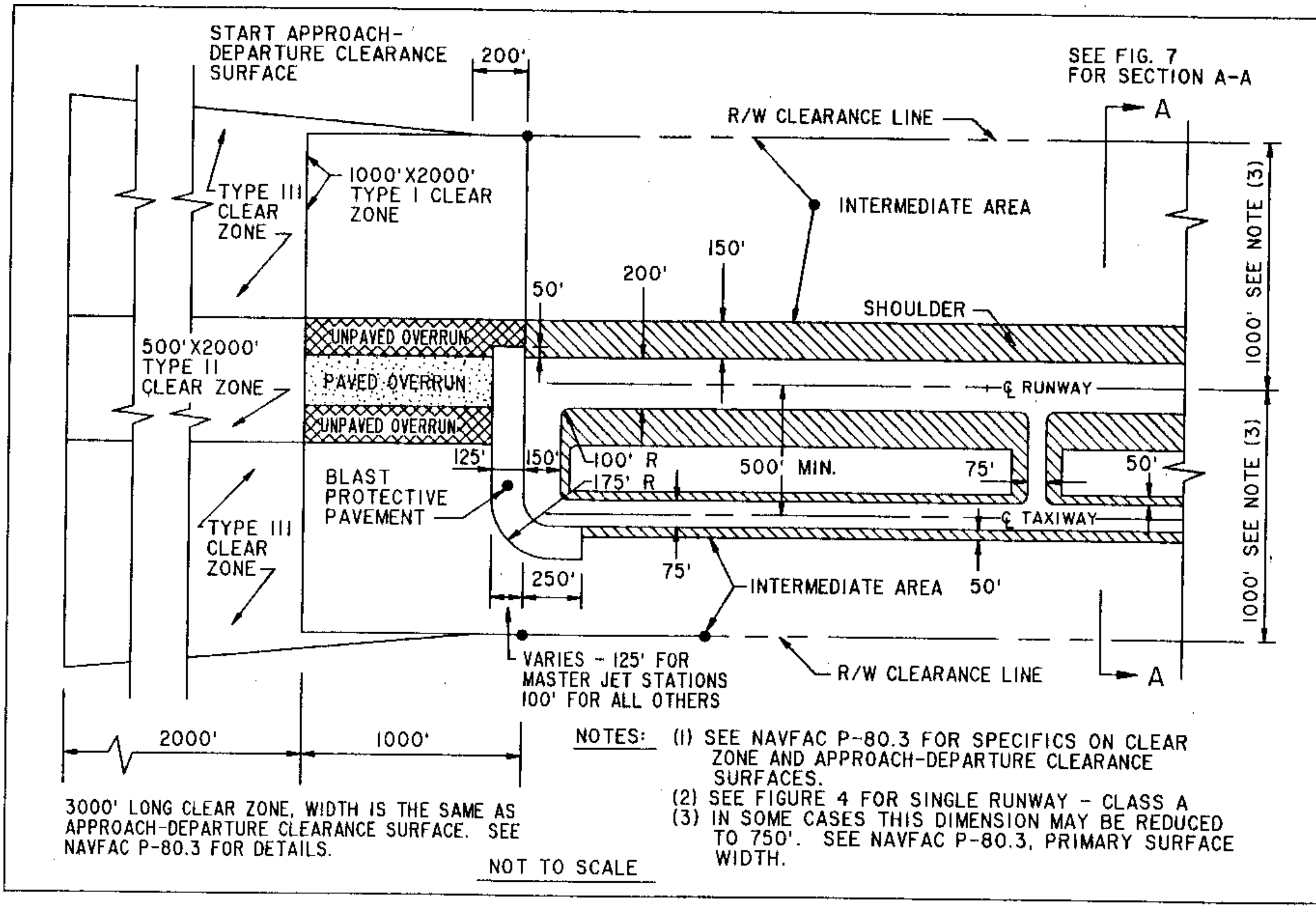


Figure 5
Plans - Single Runway - Class B

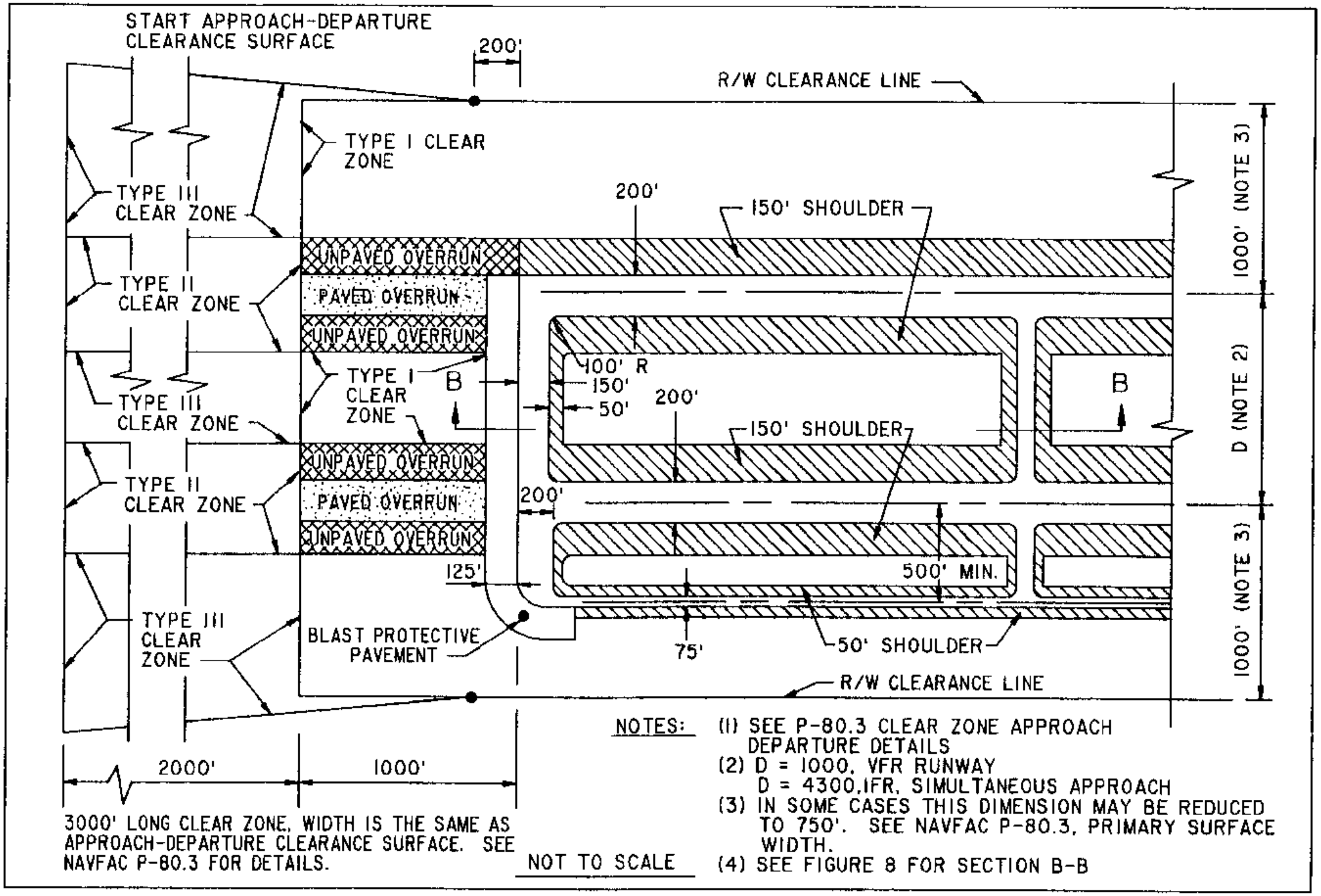


Figure 6
Typical Layout
Class B Dual Runways

4.3.2 Temperature Measurements. When new runways are designed for existing airfields, measure air temperature at a point 5 feet above the surface of an existing runway or paved area, and correlate with the mean highest temperature recorded by the National Weather Service or other long-term weather observations. Protect temperature measuring instruments from heat radiated by the pavement. For new air stations, compare temperatures 5 feet above pavements of existing runways at nearest airport having recorded temperatures, and estimate the possible correction factor for the new site. When measuring air temperatures above existing pavements, select pavements with the same color and composition as a proposed pavement, whenever possible.

4.4 Pavement. The strength and dimensions of the runway and the shoulders must be determined.

4.4.1 Runway. Load-bearing capacity shall be provided for the wheel loadings and tire pressures of the design aircraft in accordance with MIL-HDBK-1021/2, General Concepts for Airfield Pavement Design, MIL-HDBK-1021/4, Rigid Pavement Design for Airfields, and NAVFAC DM-21.03, Flexible Pavement Design for Airfields. For selection of pavement type, see MIL-HDBK-1021/2, MIL-HDBK-1021/4, and NAVFAC DM-21.03. High-speed jet aircraft need the maximum practicable pavement surface smoothness attainable, consistent with adequate braking and nonskid characteristics. For dimensions, grades, and other criteria, see Table 2.

4.4.2 Runway Shoulders. The inner 10 feet of the shoulder, contiguous to the landing area pavement, shall be paved. See MIL-HDBK-1021/2, MIL-HDBK-1021/4, and NAVFAC DM-21.03 for design loadings and thickness design procedure. The remainder of the shoulder is not designed to support aircraft or vehicular loading. For dimensions and surfacing criteria, see Table 3.

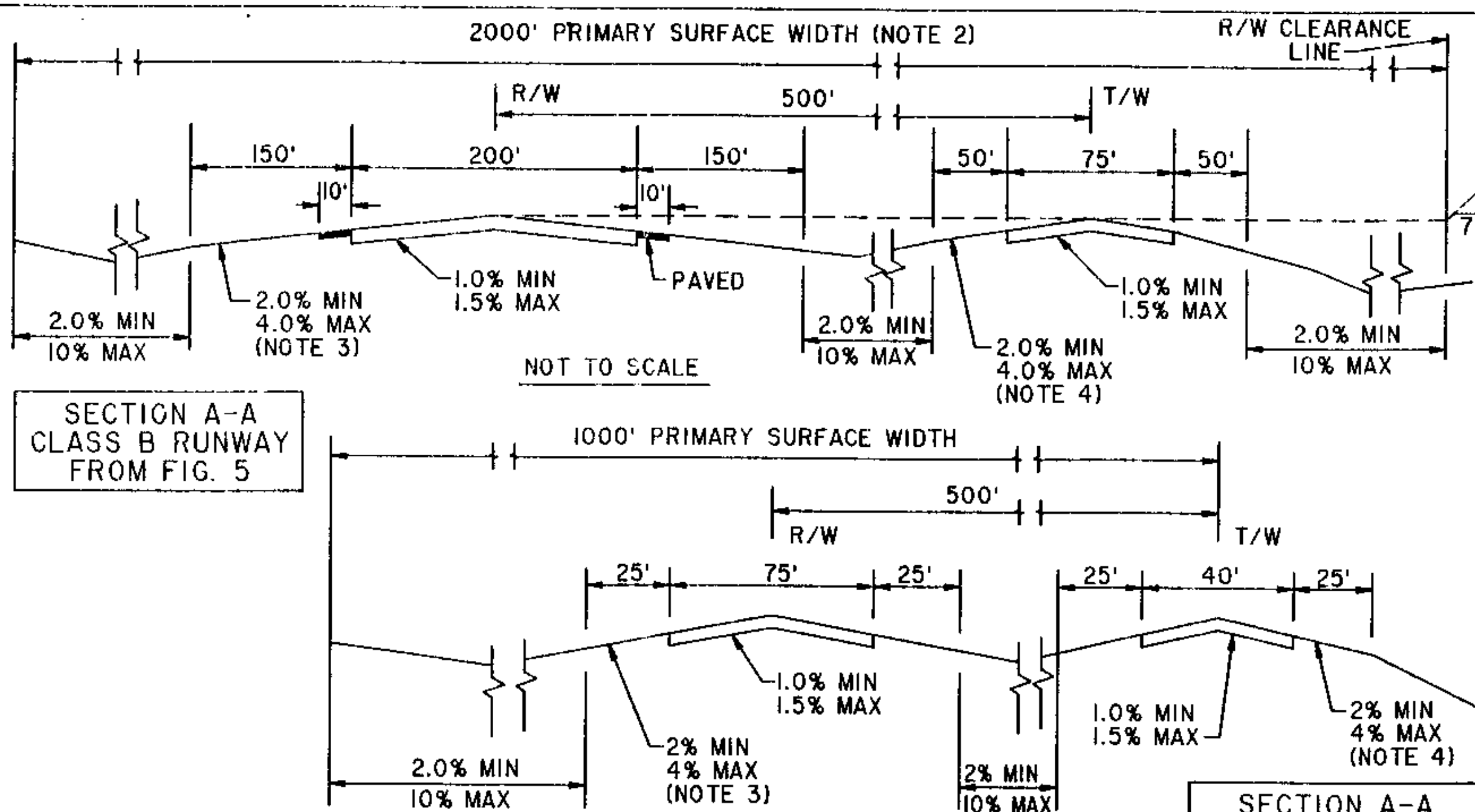
4.5 Other Areas. The other areas include the intermediate areas between runways and taxiways and the overrun and clear zone areas at the ends of the runway.

4.5.1 Intermediate Areas. Sizes of intermediate areas are determined by runway and taxiway layout. In width, the intermediate area extends from the edge of the runway shoulder to the runway clearance line or to the edge of the shoulder of a parallel runway or taxiway, whichever comes first. For typical dimensions and grade requirements for single and dual runway systems, see Figures 4, 5, 6, 7, and 8. Intermediate areas shall be cleared, graded, and protected against erosion.

4.5.2 Overrun Areas. For typical configurations of stabilized areas, blast protective pavement, and overrun areas, see Figures 4, 5, and 6. Dimensions, grades, and surfacing of these areas shall be in accordance with criteria in Table 4. See Figures 9 through 12 for longitudinal grades and transverse sections.

TABLE 3
Runway Shoulder Design Criteria

Item	Criteria
Width:	
Class A Runway	25 feet on each side of runway.
Class B Runway	150 feet on each side of runway.
Longitudinal Grades:	1.0% maximum. Hold to minimum practical. A 3.0 percent maximum is permitted where arresting gear are installed.
Transverse Grades:	Slope from runway pavement edge:
Class A Runway	5.0% first 10 feet, followed by 2.0% minimum to 4.0% maximum.
Class B Runway	2.0% minimum. 4.0% maximum. Unpaved shoulders may be increased to 5.0% for first 10 feet.
Surface:	
Class A and B Runways	First 10 feet: Pave (See MIL-HDBK-1021/2/4 and DM 21.03 for design loadings and thickness design procedure). Remaining width of shoulder: Clear, grade, and grub all stumps and other obstructions to minimum depth of 1 foot below finish grade. Control dust and erosion by vegetative cover, liquid palliative, or combination of methods.



NOTES:

(1) FOR PLAN SEE FIGURES 4 AND 5
(2) AT EXISTING AIR INSTALLATIONS, CLASS "B" RUNWAY PRIMARY SURFACE WIDTH MAY BE 1500' IN SOME CASES. SEE NAVFAC P-80.3
(3) FOR CLASS "A" RUNWAYS, THE RUNWAY SHOULDER GRADE IS 5.0% FOR THE 10 FEET FOLLOWED BY THE SPECIFIED GRADES. FOR CLASS "B" RUNWAYS UNPAVED SHOULDER GRADES MAY BE INCREASED TO 5.0% FOR FIRST 10 FT.
(4) FOR CLASS "A" RUNWAY TAXIWAYS, THE SHOULDER GRADE IS 5.0% FOR THE 10 FEET FOLLOWED BY THE SPECIFIED GRADES. FOR CLASS "B" RUNWAY TAXIWAYS, UNPAVED SHOULDERS MAY BE INCREASED TO 5.0% FOR THE FIRST 10 FEET, FOLLOWED BY THE SPECIFIED GRADES
(5) WHERE A TAXIWAY AND ITS LATERAL CLEARANCE AREA FALL WITHIN A RUNWAY PRIMARY SURFACE (NORMALLY THE CASE AT CLASS "B" RUNWAYS) THE GRADING SPECIFIED FOR THE PRIMARY SURFACE GOVERNS.

Figure 7
Runway, Taxiway And Primary Surface Transverse Sections

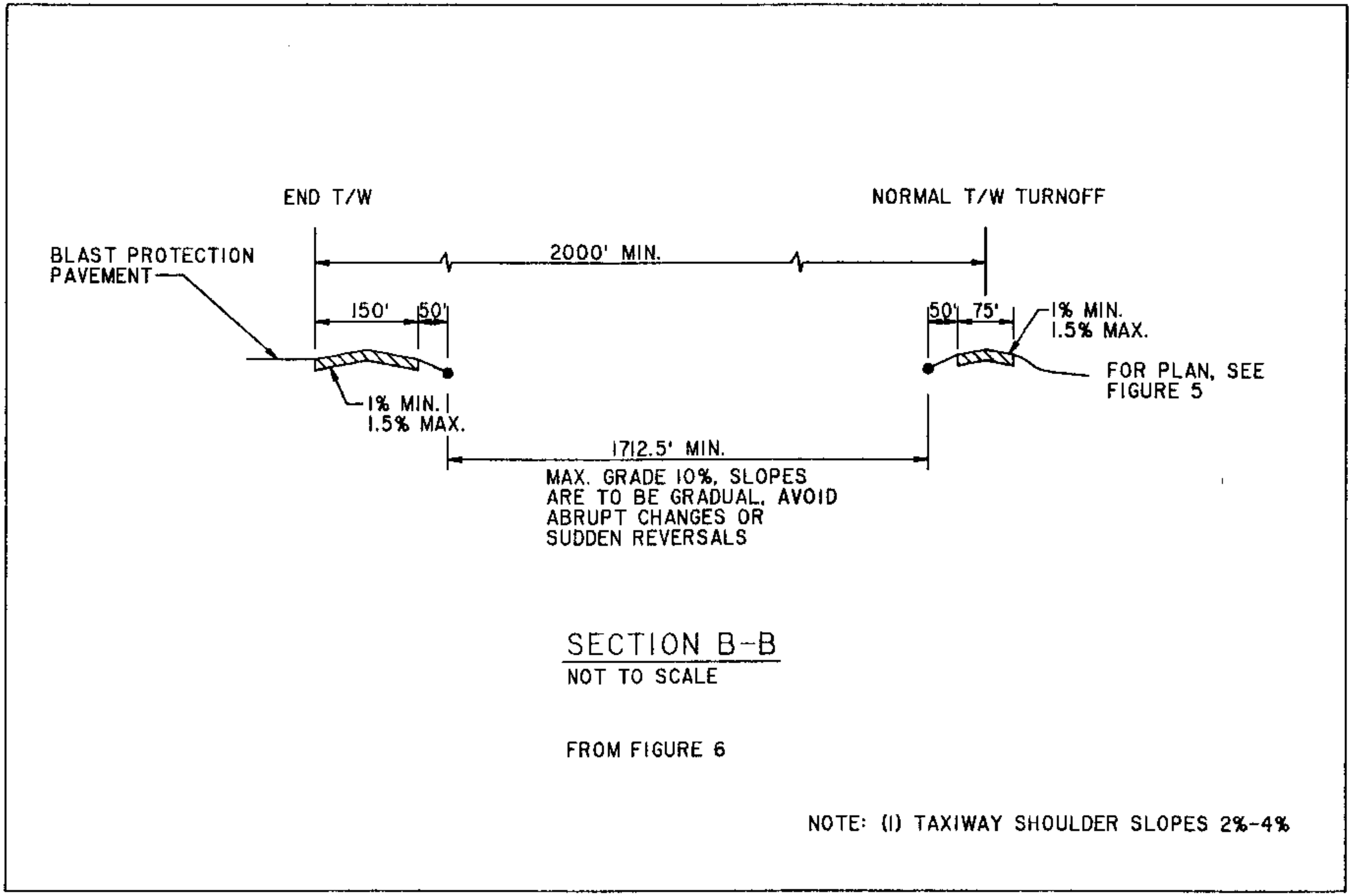


Figure 8
Class B Runway Taxiway Turnoffs Longitudinal Section

TABLE 4
Runway Overruns Including Stabilized Area, Overrun Area, and Blast Protective Pavement

Overruns		Width	Length
Dimensions	Class A	Equals width of R/W + shoulders	1000 feet
	Class B	Equals width of R/W + shoulders	1000 feet
	OLF (T-34)	Equals width of R/W + shoulders	500 feet
Longitudinal Centerline Grades	Class A/OLF (T-34)	First 200 feet same as last 1000 feet of the runway. Remainder 1.5% maximum.	
	Class B	First 300 feet, same grade as last 3000 feet of the runway. Remainder, 1.5% maximum.	
Longitudinal Grade Changes		To avoid abrupt changes in grade between the first 300 feet of overrun and the remainder of overrun, the maximum change of grade is 2.0% per 100 linear feet for Class B runways.	
Transverse Grade		See Figure 12.	
Surfaces	Class A & B Paved Overrun	Width = Runway width. Length = Same as overrun. Pave as specified in DM-21.03 and MIL-HDBK-1021/2/4.	
	Class A & B Unpaved Overrun	Width = Same as runway shoulder widths. Length = same as overrun. Treat same as outer part (exclusive of first 10 feet) of runway shoulder.	
Blast Protection	Class B Only	Provide protective pavement at all Class B runway ends. For typical layout, see Figure 6. For pavement criteria, MIL-HDBK-1021/2/4, and DM-21.03.	

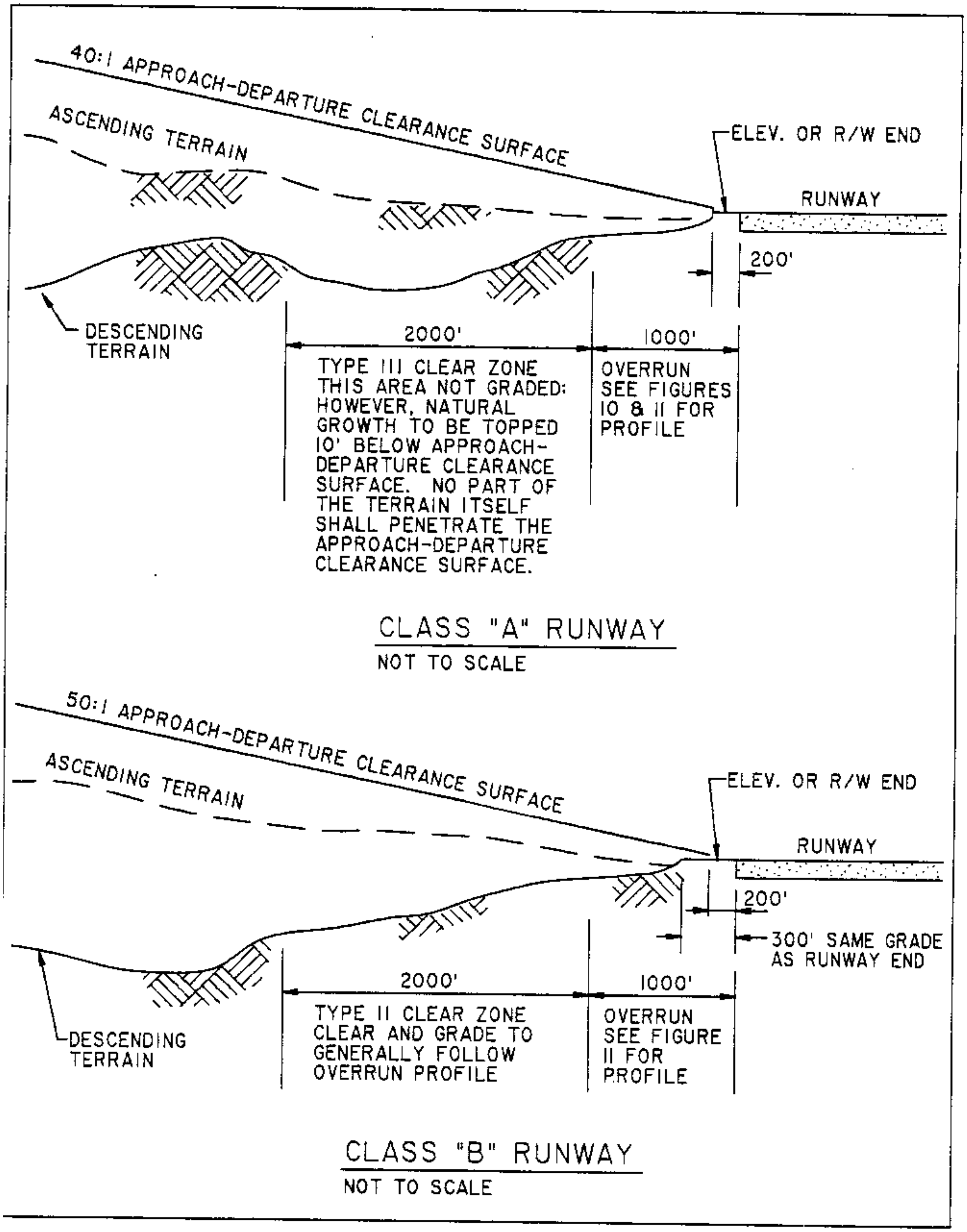
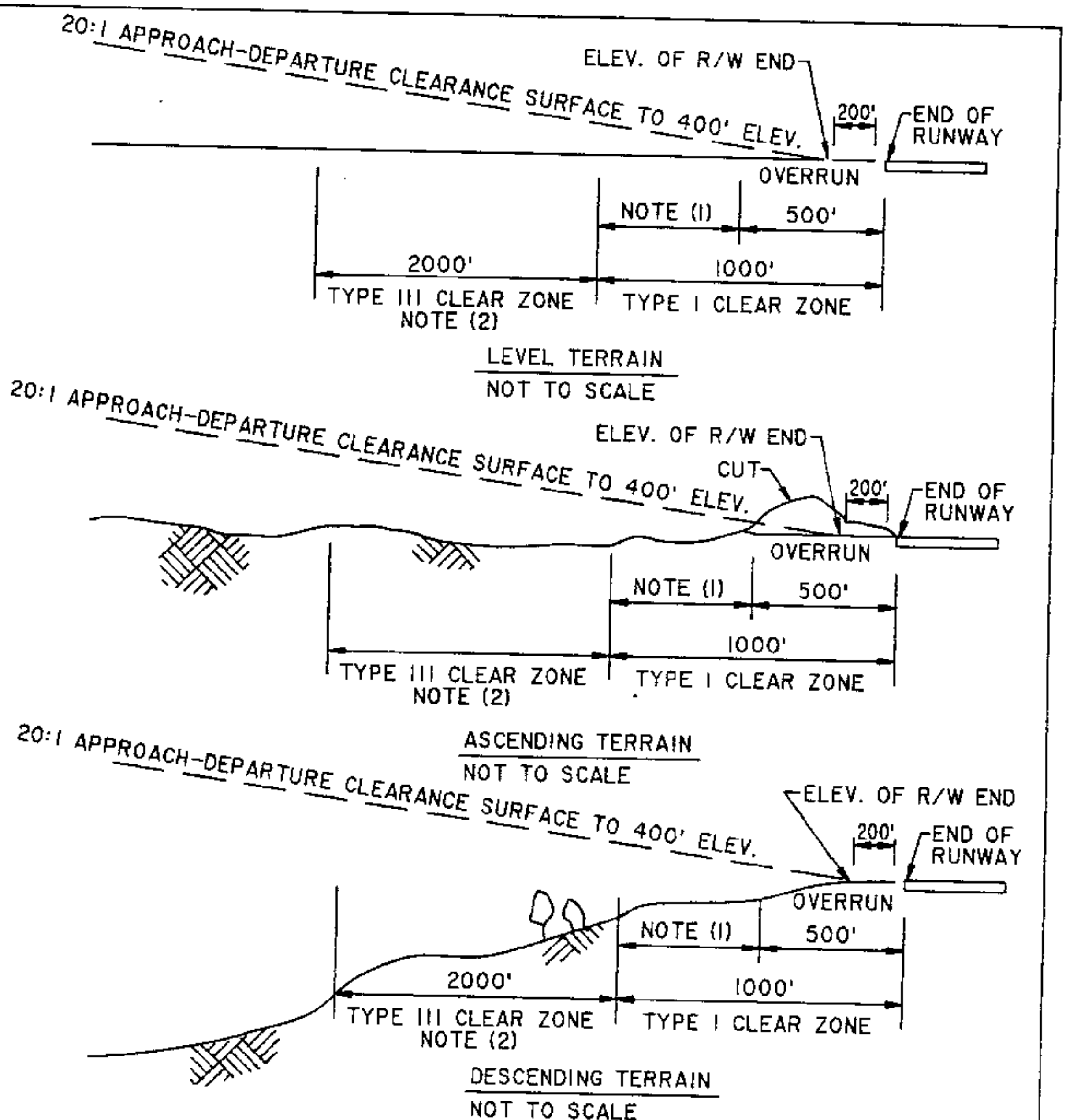


Figure 9
Longitudinal Overrun Grades
(Fleet Support and Advanced Training Airfields)



NOTE: (1) MAX LONGITUDINAL GRADE IN TYPE I CLEAR (BEYOND OVERRUN) IS 10%. MAX GRADE CHANGE IS ± 2% PER 100 FT. NO PART OF THE TERRAIN, NATURAL GROWTH OR ANY OBJECT SHALL PENETRATE THE APPROACH-DEPARTURE CLEARANCE SURFACE IN TYPE I OR III CLEAR ZONES. SEE TABLE 5.

NOTE: (2) TYPE III CLEAR ZONE IS NOT GRADED. HOWEVER, NATURAL GROWTH IS TO BE TOPPED 10 FEET BELOW THE APPROACH-DEPARTURE CLEARANCE SURFACE. NO PART OF THE TERRAIN ITSELF SHALL PENETRATE THE APPROACH-DEPARTURE CLEARANCE SURFACE.

Figure 10
Longitudinal Overrun Grades
(Basic Training Outlying Fields, T-34 Aircraft Only)

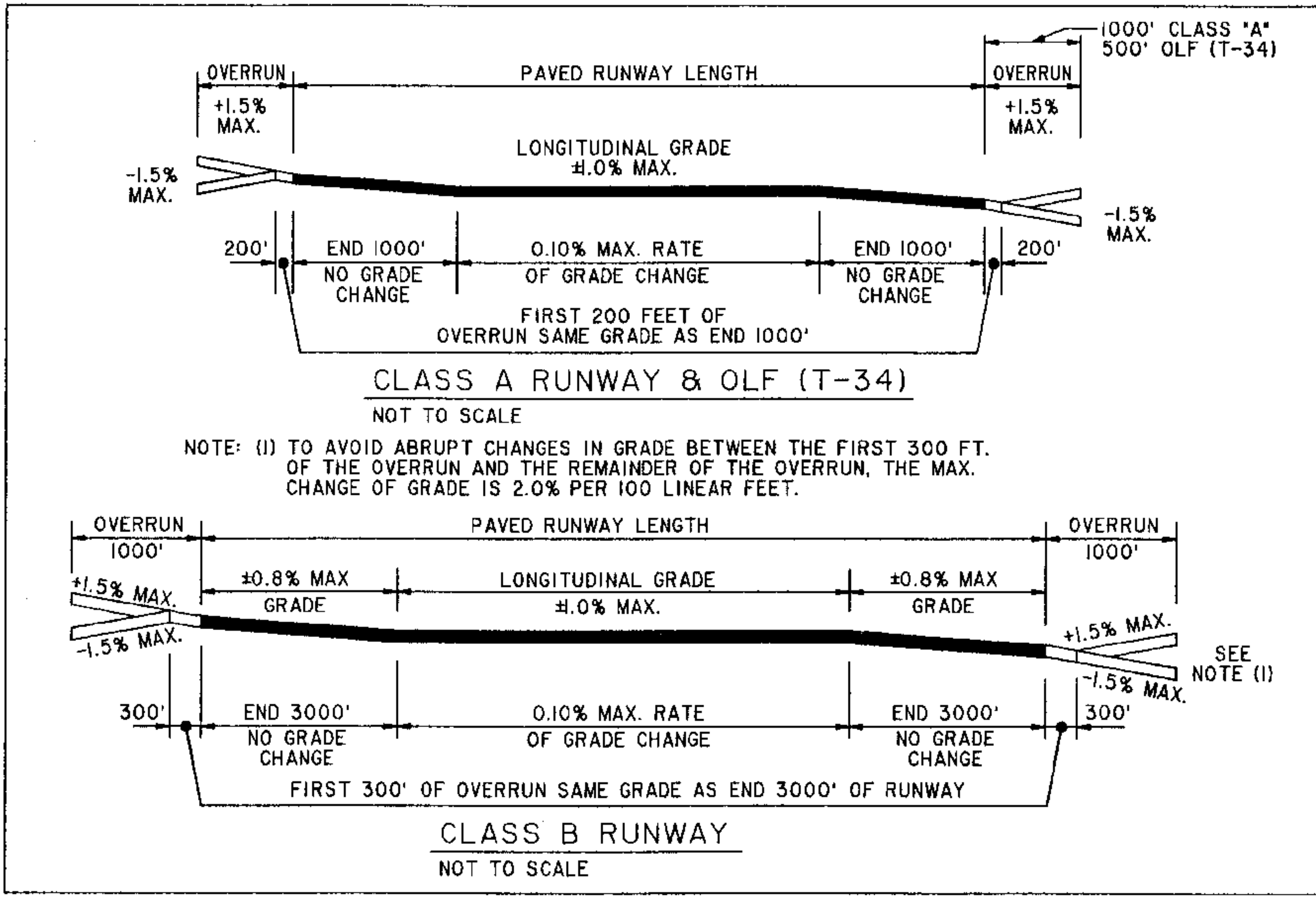
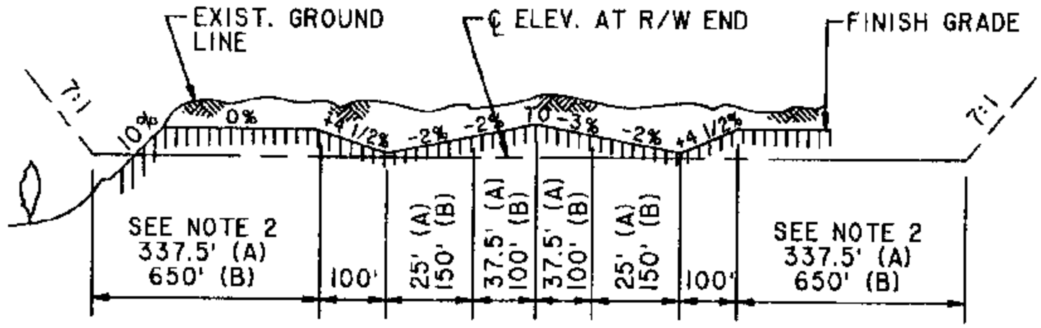
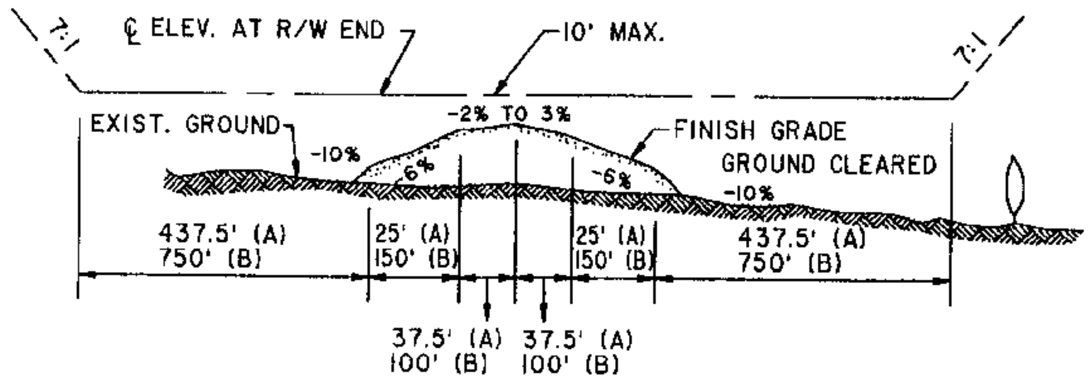


Figure 11
Runway and Overrun Longitudinal Profile



CUT SECTION
CLASS A AND B RUNWAY

NOT TO SCALE



FILL SECTION
CLASS A AND B RUNWAY
TYPICAL OVERRUN SECTIONS

NOT TO SCALE

NOTES:

(1) LONGITUDINAL GRADE SHALL BE A CONTINUANCE OF RUNWAY GRADE.
(2) WHERE 0% GRADES ARE SHOWN IN CROSS SECTION, THE LONGITUDINAL GRADE MUST BE AT LEAST 1% OR THE TRANSVERSE GRADES MUST BE CHANGED TO - 1% (MIN.) FOR DRAINAGE PURPOSES.
(3) CLASS A RUNWAY DIMENSIONS SHOWN ARE BASED ON 75 FT. WIDE RUNWAY.

Figure 12
Overrun Transverse Section

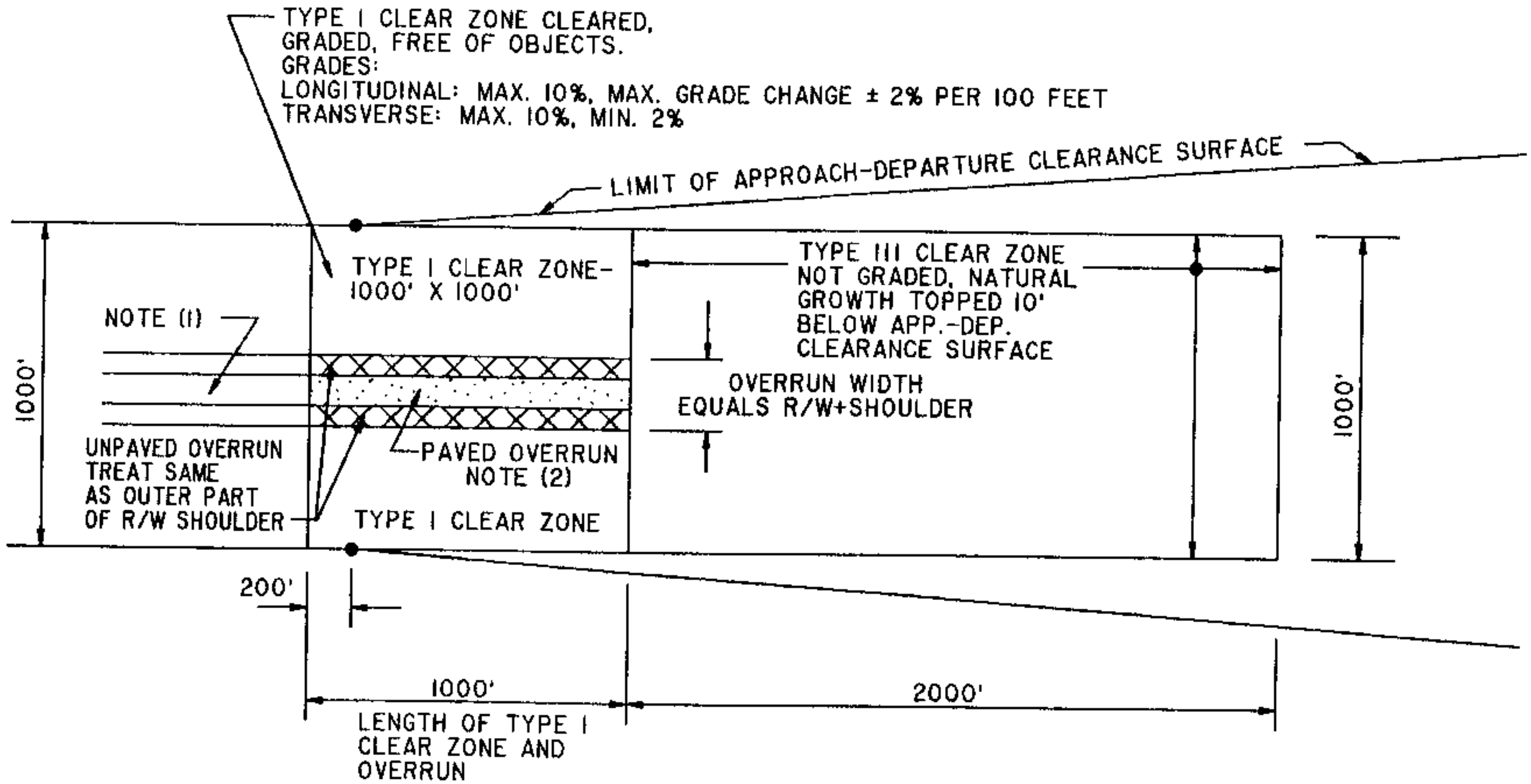
4.5.3 Clear Zones. These areas which include the overrun areas are shown in Figures 13, 14, and 15. All airfields shall have clear zones. See Figures 9 through 11 for grades and Figure 12 for transverse section detail. Other design criteria are shown in Table 5. The areas adjacent to the runway thresholds require special restrictions to provide aircraft overrun areas and unrestricted visibility of airfield lighting. To accomplish this, clear zones are specified for each class of runway and further, the clear zone is subdivided into Types I, II and III to define the degree of restrictive use. The standards herein are in conformance with clear zone sizes specified in the AICUZ program.

4.5.3.1 Clear Zone (Type I). This zone is immediately adjacent to the end of the runway. It should be cleared, graded, and free of aboveground objects (except airfield lighting) and is to receive special ground treatment or pavement in the area designated as the runway overrun. This type clear zone is required at both ends of all runways.

4.5.3.2 Clear Zone (Type II). This zone is used only for Class B runways and is an extension of the Type I clear zone except that the width is reduced. The Type II clear zone shall be graded and cleared of all aboveground objects except airfield lighting.

4.5.3.3 Clear Zone (Type III). This zone is laterally adjacent to the Type II clear zone for Class B runways and is used in lieu of the Type II clear zone at Class A runways and basic training OLFs used by T-34 aircraft. Objects in this zone shall not penetrate the approach-departure clearance surface. Trees, shrubs, bushes, or any other natural growth shall be topped 10 feet below the approach departure clearance surface or to a lesser height if necessary to ensure visibility of airfield lighting. Buildings for human habitation shall not be sited in the Type III clear zone even if they would not penetrate the approach-departure clearance surface. The land in this type clear zone is best utilized for agriculture or permanent open space exclusive of agricultural uses which would attract birds or waterfowl. Land uses which would include human activity for extended periods or group activities should be avoided. Traverse ways (roads, railroads, canals, etc.,) are permitted provided they would not penetrate airfield imaginary surfaces after the height of the traverse way has been increased by the distances specified in Section II, paragraph B of NAVFAC P-80.3.

4.5.3.4 Grading Requirements. The area to be graded is the Type I clear zones. Grades are exclusive of the overrun, but are to be shaped into the overrun grade. The maximum longitudinal grade change cannot exceed 2.0 percent per 100 feet. The graded area is to be cleared and grubbed of stumps and free of abrupt surface irregularities, ditches, and ponding areas. No aboveground structures, objects, or traverse ways are permitted in the area to be graded, but gentle swales, subsurface drainage, covered culverts, and underground structures are permissible. The transition from the graded area to the remainder of the clear zone is to be as gradual as feasible. No part of either area can penetrate the approach-departure clearance surface. For policy regarding permissible facilities, geographical features, and land use in the remainder of the clear zone, refer to NAVFAC P-80.3. In addition, the Type II clear zone shall be cleared and graded to generally follow the overrun profile.

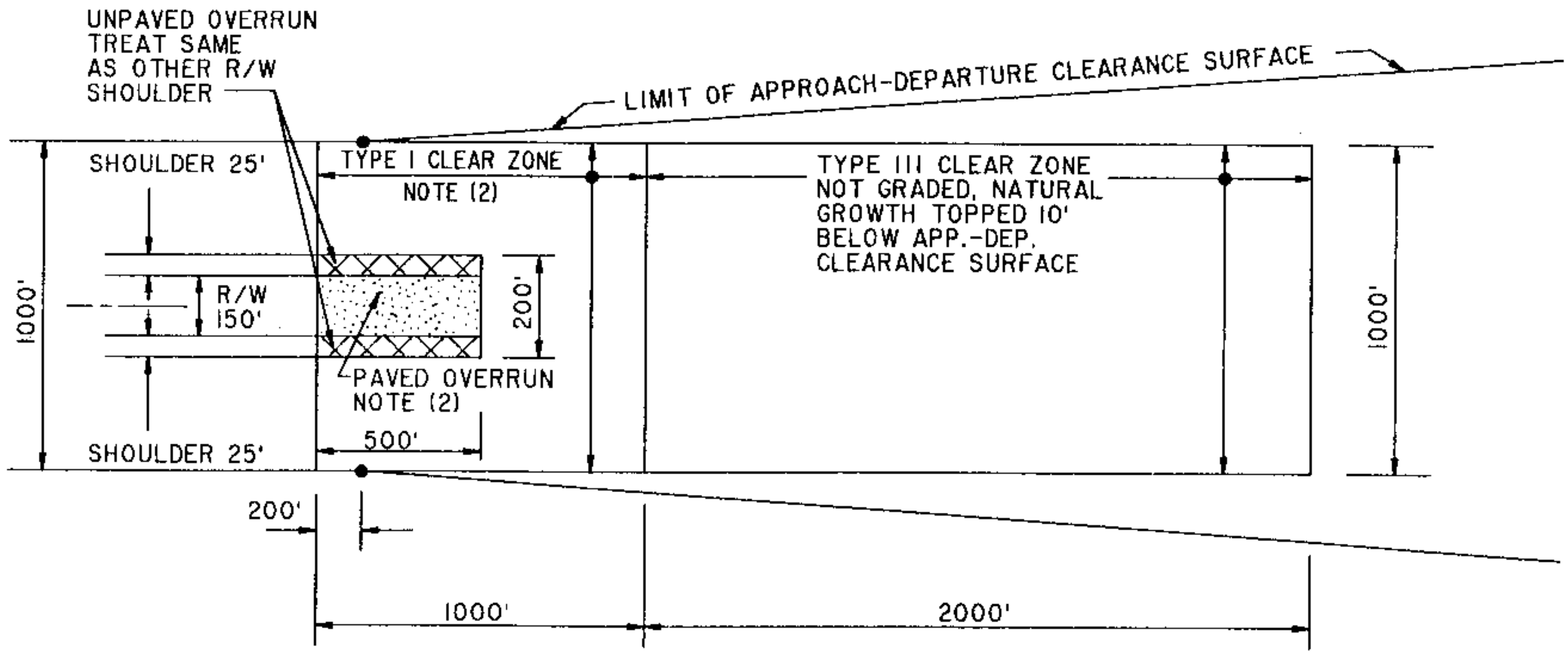


NOTES:

(1) R/W AND SHOULDER WIDTHS VARY DEPENDING ON DATE RUNWAY BUILT. SEE NAVFAC P-80.
MAX. R/W WIDTH = 200 FEET, MIN = 75 FEET
MAX. SHOULDER WIDTH = 150 FEET, MIN = 25 FEET
(2) OVERRUN GRADES:
LONGITUDINAL GRADE: FIRST 200 FEET SAME AS 1000 FEET OF R/W, REMAINDER 1.5%
TRANSVERSE GRADE: 2.0% MIN, 3.0% MAX.

NOT TO SCALE

Figure 13
Class A Runway
Overrun and Clear Zone Grades



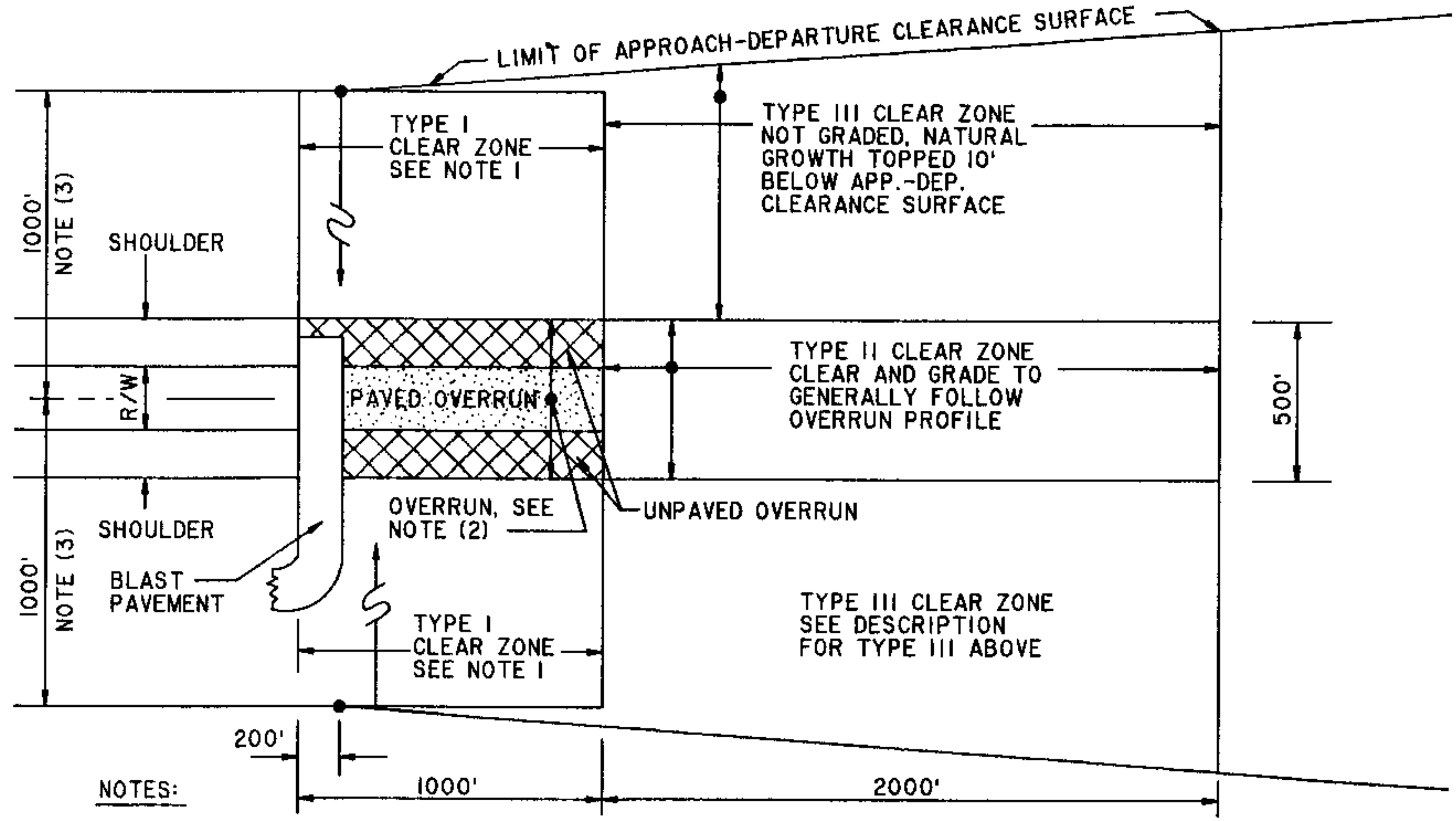
NOTES:

(1) OVERRUN WIDTH = R/W + SHOULDERS = 200'
LENGTH = 500 FEET
LONG. ℄ GRADE: FIRST 200 FEET SAME AS LAST 1000 FT OF R/W, REMAINDER 1.5%
TRANSVERSE = 2.0% MIN., 3.0% MAX.

(2) TYPE I CLEAR ZONE IS TO BE CLEARED, GRADED AND FREE OF ABOVEGROUND OBJECTS.
GRADES: LONGITUDINAL - MAX 10%, MAX GRADE CHANGE ± 2.0% PER 100 FEET
TRANSVERSE - MAX 10%, MIN 2.0%

NOT TO SCALE

Figure 14
Olf (T-34) Runway Overrun And Clear Zone Grades



NOTES:

(1) TYPE I CLEAR ZONE IS TO BE CLEARED, GRADED AND FREE OF ABOVE GROUND OBJECTS.
GRADES: LONGITUDINAL MAX 10%, MAX GRADE CHANGE ± 2.0% PER 100 FEET
TRANSVERSE MAX 10%, MIN 2%

(2) OVERRUN: LONGITUDINAL GRADE, FIRST 300 FEET SAME AS LAST 3000' OF R/W,
REMAINDER 1.5% MAX
MAX LONG. GRADE CHANGE 2% PER 100 FEET

(3) THE USE OF THE PREVIOUS STANDARD, 750 FEET MAY BE ACCEPTABLE FOR USE AT EXISTING AIR INSTALLATIONS, SEE NAVFAC P-80

NOT TO SCALE

Figure 15
Class B Runway
Overrun and Clear Zone

TABLE 5
Clear Zone Dimensions

Type Runway	Clear Zone Length	Clear Zone Width	Remarks
Class A	3000 ft	1000 ft	NOTE 1
Class B	3000 ft	Same as approach departure-clearance surface	
Basic Training OLF (T-34)	3000 ft	1000 ft	NOTE 2

NOTE 1. The criteria for Class A runway clear zones should only be applied after the Chief of Naval Operations (CNO)/Commandant of the Marine Corps (CMC) has approved the classification of a particular runway as Class A. The DOD AICUZ program (OPNAVINST 11010.36) allows for a rectangular clear zone with a 3000 foot width for new construction, however, Navy accident data indicates the fan shaped clear zone is adequate for Navy installations. Clear zones with 3000 foot widths shall not be planned unless coordinated with Headquarters, NAVFACENGCOM.

NOTE 2. The width of clear zone for basic training OLFs used by propeller aircraft was previously defined by the width of the approach-departure clearance surface. The criteria have been revised to conform with AICUZ guidelines.

Section 5: HELICOPTER LANDING AREA

5.1 Function. Helicopter landing areas include helicopter operational areas, helicopter practice pads, helipads, and helicopter runways. They are used for landing and takeoff, parking, and training incident to rotary-wing aircraft operations. See NAVFAC P-80.3, Appendix E, Airfield Safety Clearances, for typical helicopter airfield layouts and clearance requirements.

5.2 Common Criteria. The following criteria are common to all helicopter landing areas:

5.2.1 Pavement Type. Select pavement type, rigid or flexible, based on criteria stated in NAVFAC MIL-HDBK-1021/2. All pavement shall be resistant to rotor blast.

5.2.2 Wheel Loads and Tire Pressures. Design for wheel loads and tire pressures as prescribed in NAVFAC MIL-HDBK-1021/2.

5.2.3 Identification Marker. For standard helicopter landing area identification marker and its location, see NAVAIR 51-50AAA-2.

5.2.4 Wind Indicator. Provide day and night wind indicator, Federal Aviation Administration (FAA) AC 150/5345-27, Specification for Wind Cone Assemblies or in accordance with NAVAIR 51-50AAA-2.

5.2.5 Clearance Surface Intersection. Where airspace clearance surfaces intersect those of an adjacent runway, apply the most critical criteria.

5.3 Helicopter Practice Pads. A helicopter practice pad is designed for takeoff, landing, and maneuvering of rotary-wing aircraft for training purposes. The practice pad shall be constructed in an area which allows pilot training without interference with main base traffic. The pad shall consist of three helicopter runways arranged in triangular configuration to best fit terrain, airspace, and wind condition. For criteria, see Table 6 and Figure 16.

5.4 Helicopter Runways. A separate helicopter runway is constructed where site conditions, aircraft traffic density, or other operational problems require separation of rotary- and fixed-wing aircraft operations. A paved runway with stabilized shoulders is required and, if necessary for adequate wind coverage, a secondary runway shall be provided. A helicopter runway designated for IFR use shall have airspace clearances similar to that shown for IFR helipad in NAVFAC P-80.3, Appendix E, Airfield Safety Clearances. The ground position indicator designated for the runway is 75 feet from the runway end. See Section 2 for orientation criteria. For design criteria, see Table 7. For typical VFR and IFR runway details, see Figures 17 and 18.

TABLE 6
Helicopter Practice Pads

Item	Criteria
Location	Where traffic will not interfere with main base traffic.
Paved area	Runway pavement shall be 1000 feet long and 100 feet wide. Three runways are required for practice pad. Grades are the same as for operational areas; see Table 7.
Shoulders	Minimum width: 25 feet. Transverse Grade: -5% for first 10 feet, then: Maximum grade: -4%. Minimum grade: -2%. Shoulder shall be select material, compacted and stabilized with asphalt or other material to protect against rotor blast.
Overrun	Length: 75 feet. Width: Width of runway plus shoulders.
Takeoff safety zone	Length: 800 feet. Width: Same as approach surface.
Marking	For runway marking, see NAVAIR 51-50AAA-2.
Wind indicator	Provide day and night wind indicator.
Access road	Provide all-weather access road.

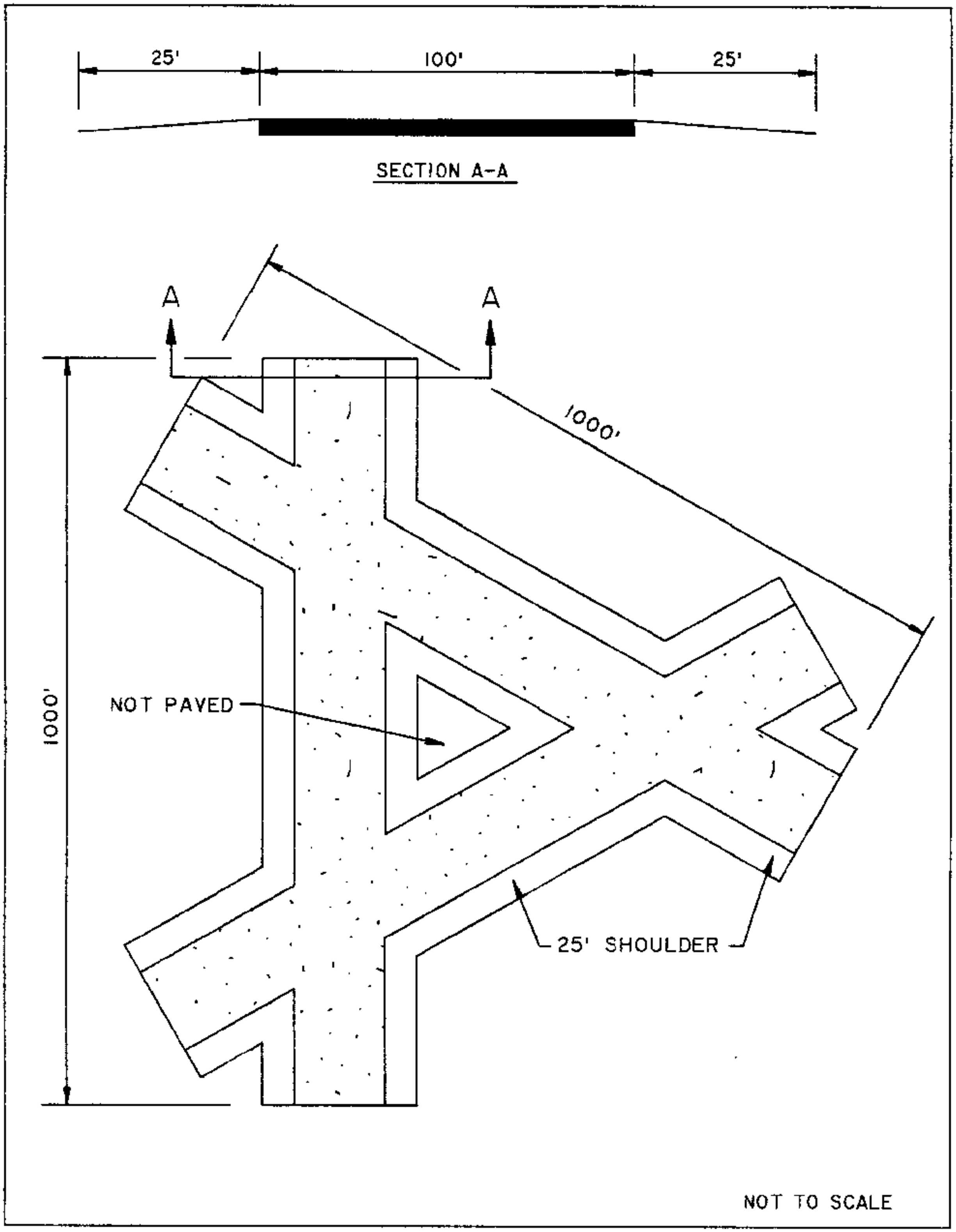


Figure 16
Helicopter Practice Pad

TABLE 7
Helicopter Runway (VFR and IFR)

Item	Criteria
Location	Where desirable to separate fixed-wing aircraft traffic from rotary-wing aircraft traffic.
Pavement	Basic length: 450 feet.* Width: 75 feet; on airfields accommodating H-53 aircraft, 100 feet minimum. Maximum irregularity: + 1/8 inch in 10 feet for rigid pavement. + 1/4 inch in 10 feet for flexible pavement. Longitudinal grade: 1.0% maximum. Transverse grade: 1.0% minimum 1.5% maximum.
Aprons	See Table 12.
Overrun	Length: 75 feet. Width: Width of runway plus shoulders. Longitudinal centerline grade: Same as last 100 feet of runway. Transverse grade: 2.0% minimum. Warp to meet runway 3.0% maximum. and shoulder grades
Takeoff safety zone (VFR helicopter run-way only)	Length: 400 feet (except triangular-helicopter practice pad where L = 800 feet). Width: 300 feet (inner edge). Corresponds to the width of the primary surface. Width: 400 feet (outer edge) (except triangular-helicopter practice pad where W = 700 feet) Grades in any direction: 5.0% maximum, area to be free of obstructions. Rough grade and turf when required. No takeoff safety zone is required at IFR helicopter runway due to extensive primary surface area beyond the ends of the runway.

* Basic length to be corrected for elevation and temperature. Increase 10.0 percent for each 1000 feet in elevation above 2000 feet M.S.L. and add 4.0 percent for each 10o F above 59o F for the average daily maximum temperature of the hottest month. For a special mission or proficiency training such as autorotation operations, the length may be increased up to 1000 feet in which case make no additive corrections.

TABLE 7 (Continued)
Helicopter Runway (VFR and IFR)

Item	Criteria
Shoulders	Width: 25 feet. The 25 feet shall be select material compacted and stabilized with asphalt or other material to protect against rotor blast. Longitudinal grade: variable, conform to longitudinal grade of the abutting primary pavement. Transverse grade: -5% for first 10 feet, then: -2% minimum. -4% maximum.
Taxiways	See Table 10.
Marking	For runway and taxiway marking, see NAVAIR 51-50AAA-2.
Runway lateral clearance distance	VFR: 150 feet. IFR: 375 feet. Measured from centerline of runway to fixed and mobile obstacles. (1) Fixed obstacles include manmade or natural features constituting possible hazards to moving aircraft. Navigational aids and meteorological equipment are possible exceptions. Additional siting criteria in NAVFAC P-80.3. (2) Mobile obstacles include parked aircraft, parked and moving vehicles, railroad cars, and similar equipment. (3) Taxiing aircraft exempt from this restriction. (4) Size of primary surface: VFR Runway (See Figure 17): W = 300 feet. L = R/W length + 75 feet each end. IFR Runway (See Figure 18): W = 750 feet. L = Varies, extends beyond runway 775 feet from ground point intercept.
Grades within primary surface area in any direction	5.0% maximum. Exclusive of pavement and shoulders.

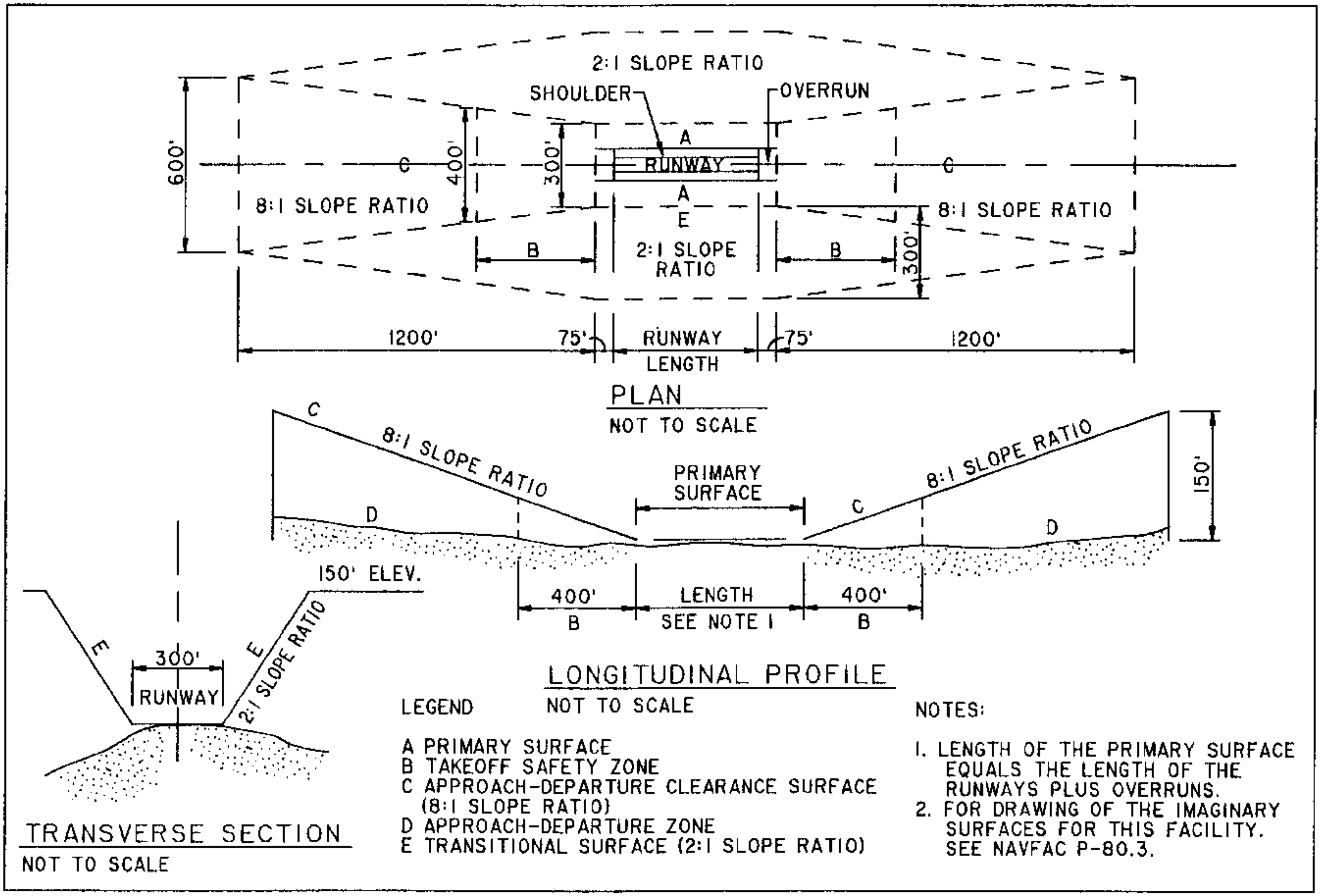


Figure 17
Helicopter VFR Runway

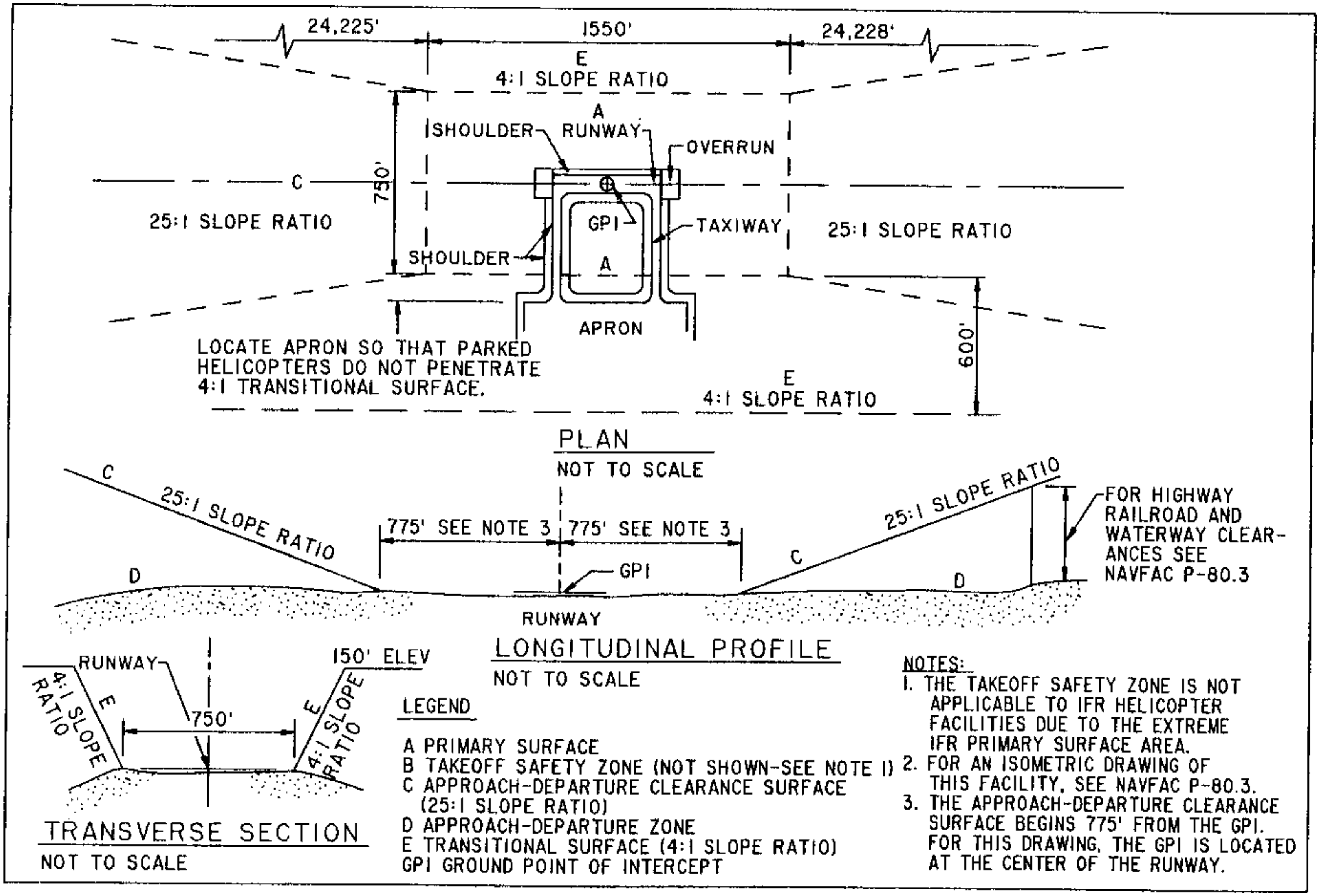


Figure 18
Helicopter IFR Runway

5.5 Helipads. Helipads are special pads for landing and takeoff of single rotary-wing aircraft. They are placed near hospital, administrative, or other facilities, or at suitable locations on airfields with high air traffic density condition. For criteria, see Table 8. For VFR and IFR helipad details, see Figures 19 and 20. If more than one helicopter must use the pad, a connecting taxiway (Table 10) and parking apron (Table 12) shall be provided. If night operations are required, helipad lighting shall be provided (see NAVAIR 51-50AAA-2).

5.6 Helicopter Landing Lanes. A helicopter landing lane is a landing and takeoff facility that permits more rapid launch and recovery operations than otherwise can be provided by a single runway or helipad. These lanes provide for simultaneous use by a number of helicopters, up to four at one time, while additional helicopters are in a designated traffic pattern. See Table 9 and Figure 21 for the principal dimensional criteria and clearances for a landing lane and for a typical landing lane layout. Landing lanes shall not be designed for Navy and Marine Corps activities without prior approval from the Naval Air Systems Command (AIR-4223).

TABLE 8
Helipads

Item	Criteria	
Location	Adjacent to facility such as hospital or command installation and sited to conform with clearance requirements.	
Size	VFR and IFR: 100 feet x 100 feet	
Grade	1.0% minimum. 1.5% maximum.	Helipad grade shall be in one direction.
Shoulders: Shoulders adjacent to all operational pavements	25 feet.	
Longitudinal grade	Variable.	Conform to the longitudinal grade of the abutting primary pavement.
Transverse grade	5.0% first 10 feet followed by 2.0% minimum. 4.0% maximum.	Slope from pavement.
	Compact shoulder areas. Stabilization for dust and erosion control will be adequate to prevent displacement of shoulder materials by rotor blast. Dust and erosion control will be provided by vegetative cover, asphalt concrete, double-bituminous surface treatment, liquid palliative, or by combination of methods.	
Size of primary surface	VFR: 150 feet X 150 feet IFR: 1550 feet X 750 feet	
Grades within the primary surface area in any direction	2.0% minimum prior to channelization. (Bed of channel may be flat.) 5% maximum.	Exclusive of pavement and shoulders. For an IFR helipad grades applicable within the limits of a 300 foot x 300 foot area, the balance of the area is to be clear of obstructions and rough graded to the extent necessary to reduce damage to aircraft in event of an emergency landing.

TABLE 8 (Continued)
Helipads

Item	Criteria	
Length of takeoff safety zone (VFR Helipad only)	400 feet.	The takeoff safety zone area for helipads corresponds to the clear zone land use criteria for fixed-wing airfields as defined by OPNAVINST 11010.36A standards. The remainder of the approach-departure zone corresponds to APZ I land use criteria similarly defined. It does not apply to IFR helicopter facilities due to the extensive primary surface area.
Width of takeoff safety zone (inner edge)	Corresponds to the width of the primary surface. 150 feet.	
Width of takeoff safety zone (outer edge)	267 feet.	
Grades of takeoff safety zone any direction	5.0% maximum.	Area to be free of obstructions. Rough grade and turf when required.
Access Road	Provide all-weather with minimum width of 12 feet.	
Tiedowns	Provide mooring eyes for one aircraft. (See Table 13)	
Wind Indicator	Install day and night wind indicator so as to be seen from normal angle of approach and yet not be a hazard to flight operations.	
Marking	See NAVAIR 51-50AAA-2.	

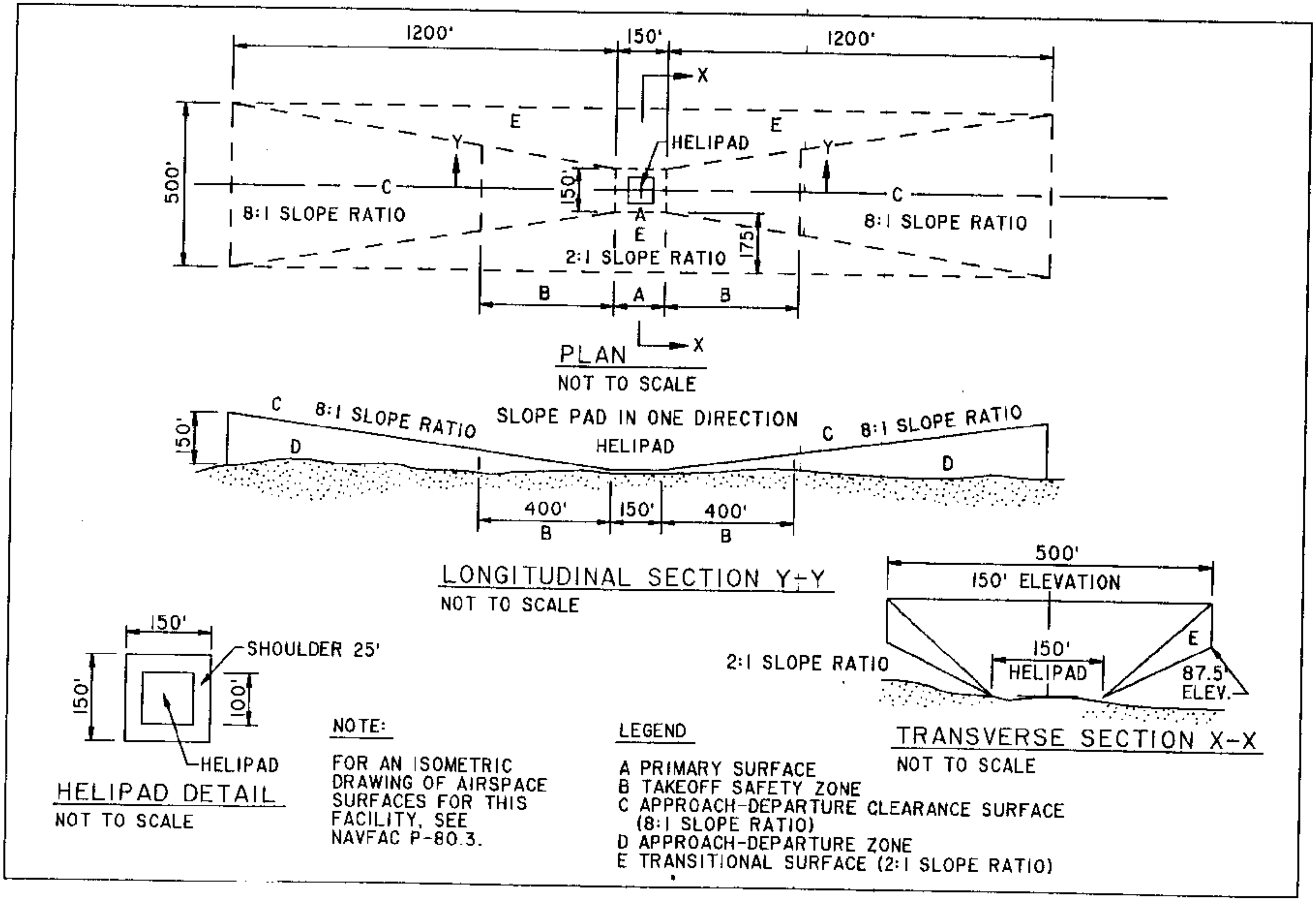


Figure 19
VFR Helipad

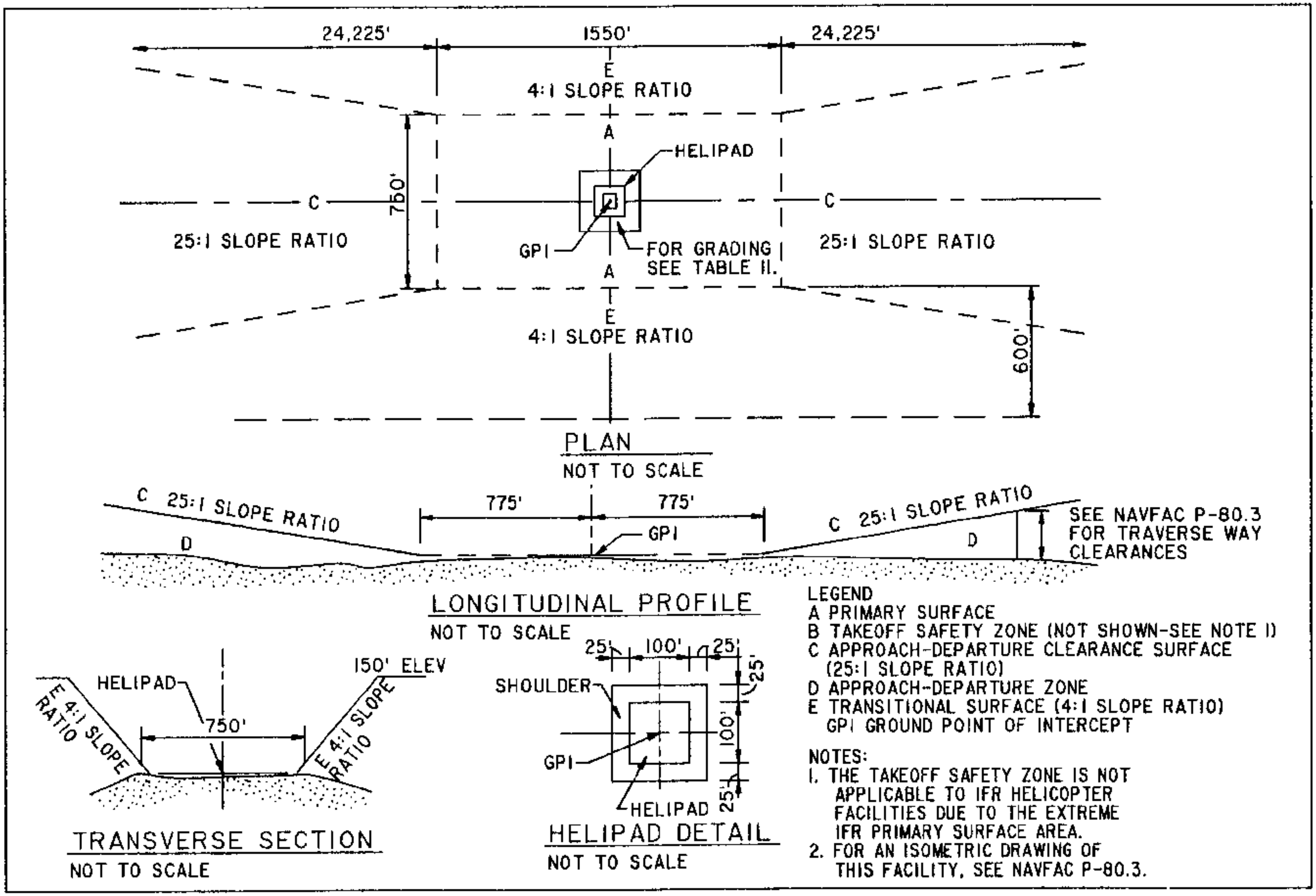


Figure 20
IFR Helipad

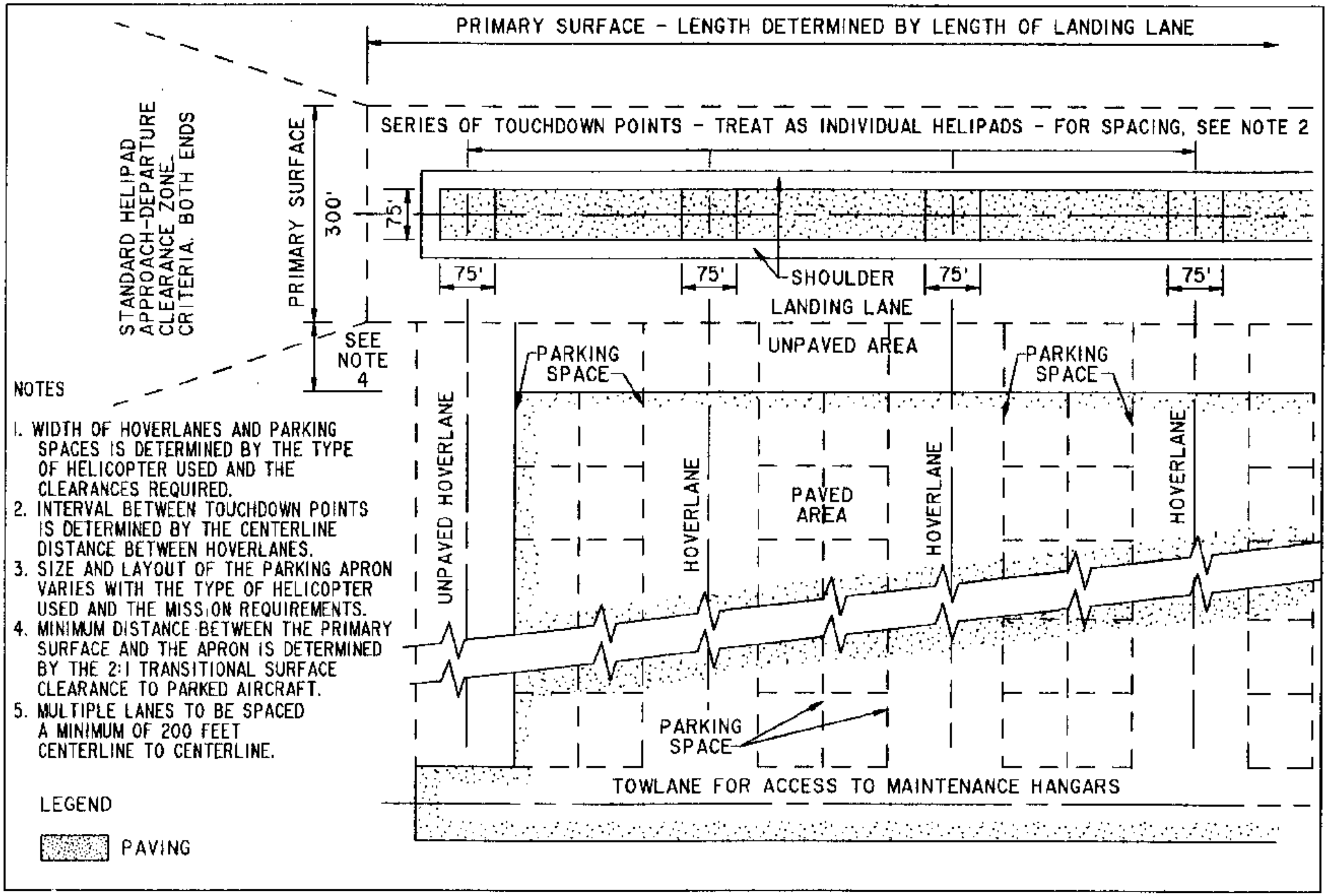


Figure 21
Helicopter Landing Lane

TABLE 9
Helicopter Landing Lanes
(See Note 1)

Item	Criteria	
Length	1600 feet to 2000 feet.	Provide a number of equally spaced "touchdown" or holding points with adequate separation, usually not less than 400 feet from center to center. Multiple lanes are to be spaced a minimum of 200 feet from centerline to centerline of lanes.
Width	75 feet.	
Shoulders:		
Shoulders adjacent to all operational pavements	25 feet.	May be increased when necessary to accommodate dual operations with fixed-wing aircraft.
Longitudinal grade	Variable.	Conform to the longitudinal grade of the abutting primary pavement.
Transverse grade	5.0% first 10 feet followed by 2.0% minimum. 4.0% maximum.	

NOTE 1: Criteria for landing lanes has been included to show the spacing between multiple VFR touchdown points on a single runway and the separation between parallel VFR runways. The layout shown in Figure 21 is for a typical U.S. Army staging field and should not be used for Navy or Marine Corps design without the prior approval of the Naval Air Systems Command.

Section 6: TAXIWAYS

6.1 Criteria. Criteria in this section include data for design of taxiways, taxiway shoulders, and runway exits to include end, normal, and high-speed turnoffs. See Table 2 for lateral clearance criteria. For criteria related to taxi lanes in parking aprons, see Table 12.

6.2 Function. Taxiways are paved surfaces which link runways with service and parking areas. They are designed to achieve a smooth flow of aircraft traffic taxiing at maximum practical speed.

6.3 Design Requirements. Taxiway pavements may be either flexible or rigid, select as described in MIL-HDBK-1021/2.

6.3.1 Taxiway Layout. The following are considerations for use in layout of taxiways:

a) Route of the taxiways should be as direct as possible from the runway to the apron.

b) Sufficient number of taxiways should be provided to prevent complicated routes which may result when one taxiway must service more than one runway.

c) Connecting taxiways must be provided to join the runway exit points to the apron.

d) Taxiways from runway to apron should not cross either taxiways or runways unless absolutely necessary.

6.3.2 Taxiway Criteria. For criteria governing taxiway geometry and design for both fixed- and rotary-wing aircraft, see Table 10 and Figures 22, 23, 24, and 25.

6.3.3 Runway Exit Criteria. The number, type, and location of exits is a function of required runway traffic capacity.

a) End Turnoffs. Provide end turnoffs at each end of the runway. They shall be designed to serve as warmup areas for aircraft preparing to take off as well as for runway exits. See Table 10 for dimensions and grades.

b) Normal Taxiway Turnoffs. Provide intermediate turnoffs from runways to allow landing aircraft to exit and clear runways as soon as possible after completing initial landing rolls. For spacing requirements, see Figure 23. For runways longer than 10,000 feet, space additional turnoffs 2000 to 3000 feet apart. See Table 10 for dimensions and grades.

TABLE 10
Aircraft Taxiways (Fixed- and Rotary-Wing Aircraft)

Item	Criteria	
Length	Dependent upon airfield configuration.	
Load-bearing capacity	See MIL-HDBK-1021/2/4 and NAVFAC DM-21.03.	
Surface	Minimum irregularity + 1/8 inch in 10 feet in any direction for rigid pavement and + 1/4 inch in 10 feet in any direction for flexible pavement.	
Width:		
Class A Runway	40 feet.	May be modified for particular mission requirements (that is, high speed and end turnoff, and large transport taxiways for B-747, KC-10, C5-A, L-1011, and A-300).
Class B Runway	75 feet.	
Rotary-Wing	40 feet.	When dual use taxiways support fixed- and rotary-wing aircraft operations, use the appropriate fixed-wing criteria.
Longitudinal grade of taxiway:		
Class A and B Runways	1.5% maximum.	Keep grades to minimum possible.
Rotary-Wing	2.0% maximum.	
Rate of longitudinal grade change per 100 feet:		
Class A and B Runways	1.0% maximum.	The minimum distance between two successive points of intersection (PIs) is 500 feet. Changes are to be accomplished by means of vertical curves. The maximum grade change is 3.0%.
Rotary-Wing	2.0% maximum.	
Transverse grade of taxiway:	1.0% minimum. 1.5% maximum.	From centerline of taxiway.
Normal taxiway turnoffs:		
Width	Class A: 40 feet. Class B: 75 feet. (Except taxiways at direct fueling stations: 150 feet.) Longitudinal grade 1.0% maximum between parallel runways. 3.0% maximum between runway and parallel taxiway.	

TABLE 10 (Continued)
Aircraft Taxiways (Fixed- and Rotary-Wing Aircraft)

Item	Criteria	
End turnoffs:	Class B (all taxiways and turnoffs for helicopter and Class A runways shall be 40 feet).	
Width	150 feet between single runway and parallel taxiway and between parallel runways; 200 feet between parallel runways and parallel taxiways. See Figures 4, 5, 6, 7, and 8.	
Longitudinal grade	1.0% maximum between parallel runways. 2.0% maximum between runway and parallel taxiway. Elevation of crown of taxiway shall be same as edge of runway at shoulder line. Grade shall start at edge of runway pavement and extend to centerline of parallel taxiway.	
Maximum allowable rate of change in grade	1.0% per 100 feet.	
Width of shoulders:		
Class A Runway	25 feet.	Except V-22, use 30 feet.
Class B Runway	50 feet.	
Rotary-Wing	25 feet.	May be increased when necessary to accommodate dual operations with fixed-wing aircraft.
Longitudinal grade of shoulders:		
Class A and B Runways	3.0% maximum.	
Rotary-Wing	Variable.	Conform to longitudinal grade of the abutting primary pavement.
Transverse grade of shoulders:		
Class A Runway	5.0% first 10 feet followed by 2.0% minimum to 4.0% maximum.	Grades for unpaved taxiway shoulders for Class B runways may be increased to 5.0% for the first 10 feet.
Class B Runway	2.0% minimum. 4.0% maximum.	
Rotary-Wing	5.0% first 10 feet followed by 2.0% minimum to 4.0% maximum.	Slope from pavement.

TABLE 10 (Continued)
Aircraft Taxiways (Fixed- and Rotary-Wing Aircraft)

Item	Criteria	
Shoulder treatment	For fixed-wing aircraft, same as outer 140 feet of the runway shoulder; for rotary-wing aircraft, and in areas where turf is difficult to establish, pave shoulders 25 feet each side.	
Sight distance:		
Class A Runway	Not applicable.	
Class B Runway and Rotary-Wing	Minimum 2000 feet between eye level at 7 feet and an object 10 feet above taxiway pavement.	
Clearance from taxiway centerline to fixed or mobile obstacles (taxiway clearance line):		
Class A Runway	100 feet minimum.	Definitions for fixed and mobile obstacles same as described in Table 2.
Class B Runway	150 feet minimum.	Basic helicopter clearance. Increase as appropriate for dual use taxiways.
Rotary-Wing	100 feet minimum.	
Grades within the clear area (Area between taxiway shoulder and taxiway clearance line):		
Class A and B Runways	2.0% minimum to 10.0% maximum.	Any direction. Rough grade to the extent necessary to prevent damage to aircraft in the event of erratic performances.
Rotary-Wing	5.0% maximum.	
Horizontal curves	Minimum radius (to taxiway centerline): 275 feet for fixed-wing aircraft. 150 feet for rotary-wing aircraft.	
Fillets at intersections	See Figures 22 and 23.	
Pavement Marking	See NAVAIR 51-50AAA-2.	

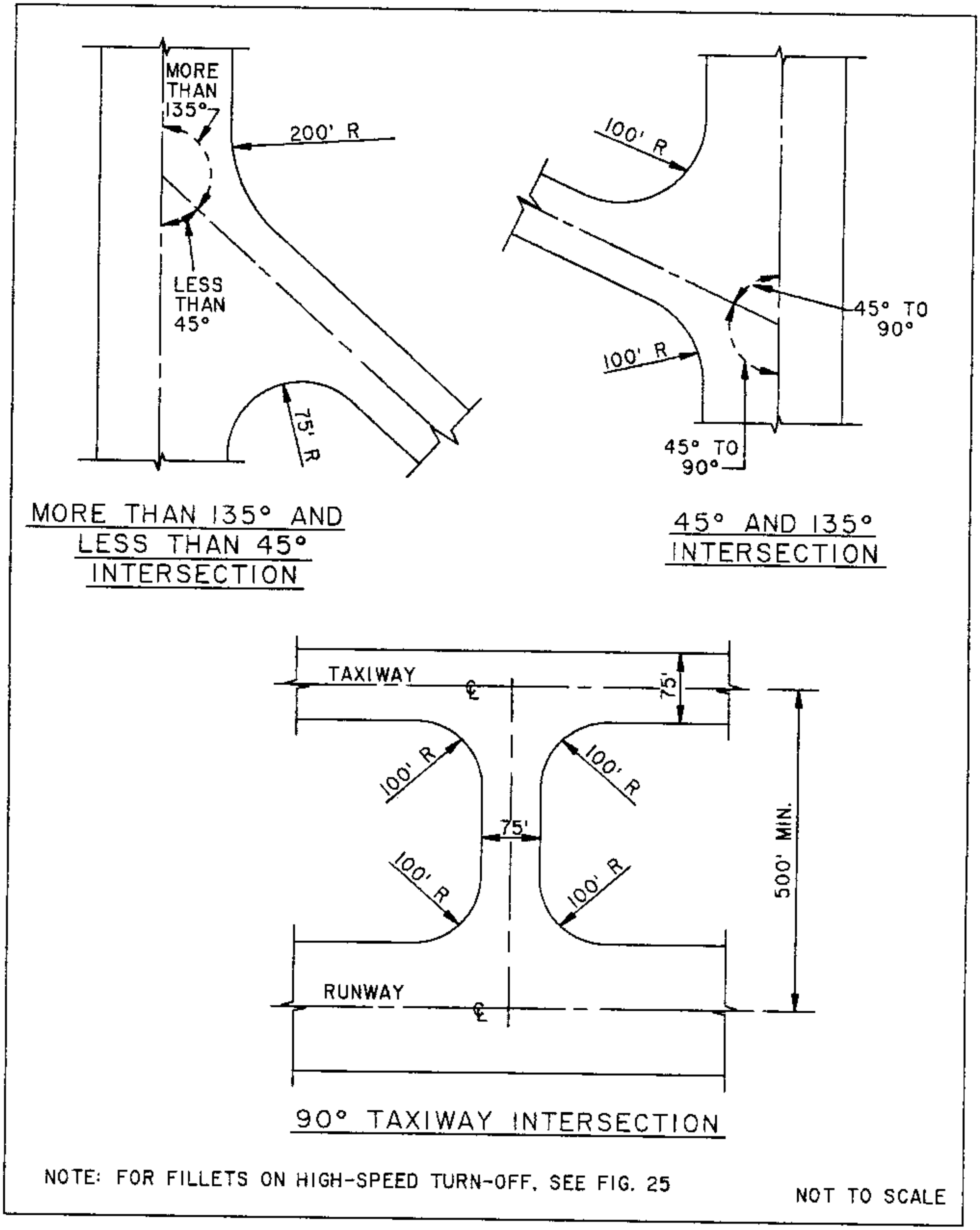


Figure 22
Typical Runway and Taxiway Fillets
Class B Runways

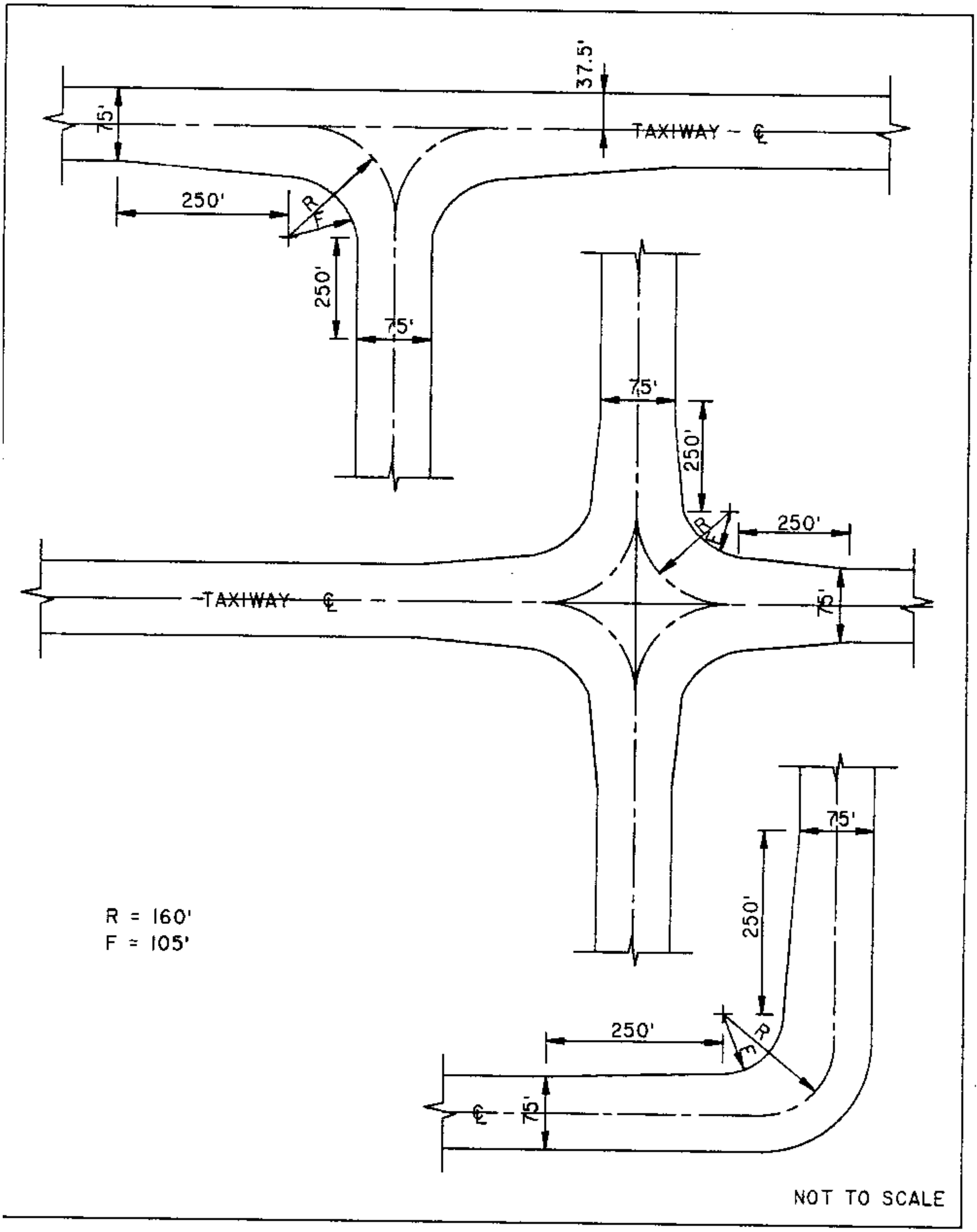


Figure 23
Taxiway Intersections for Airfields Serving
Large Transport Aircraft Class B Runways

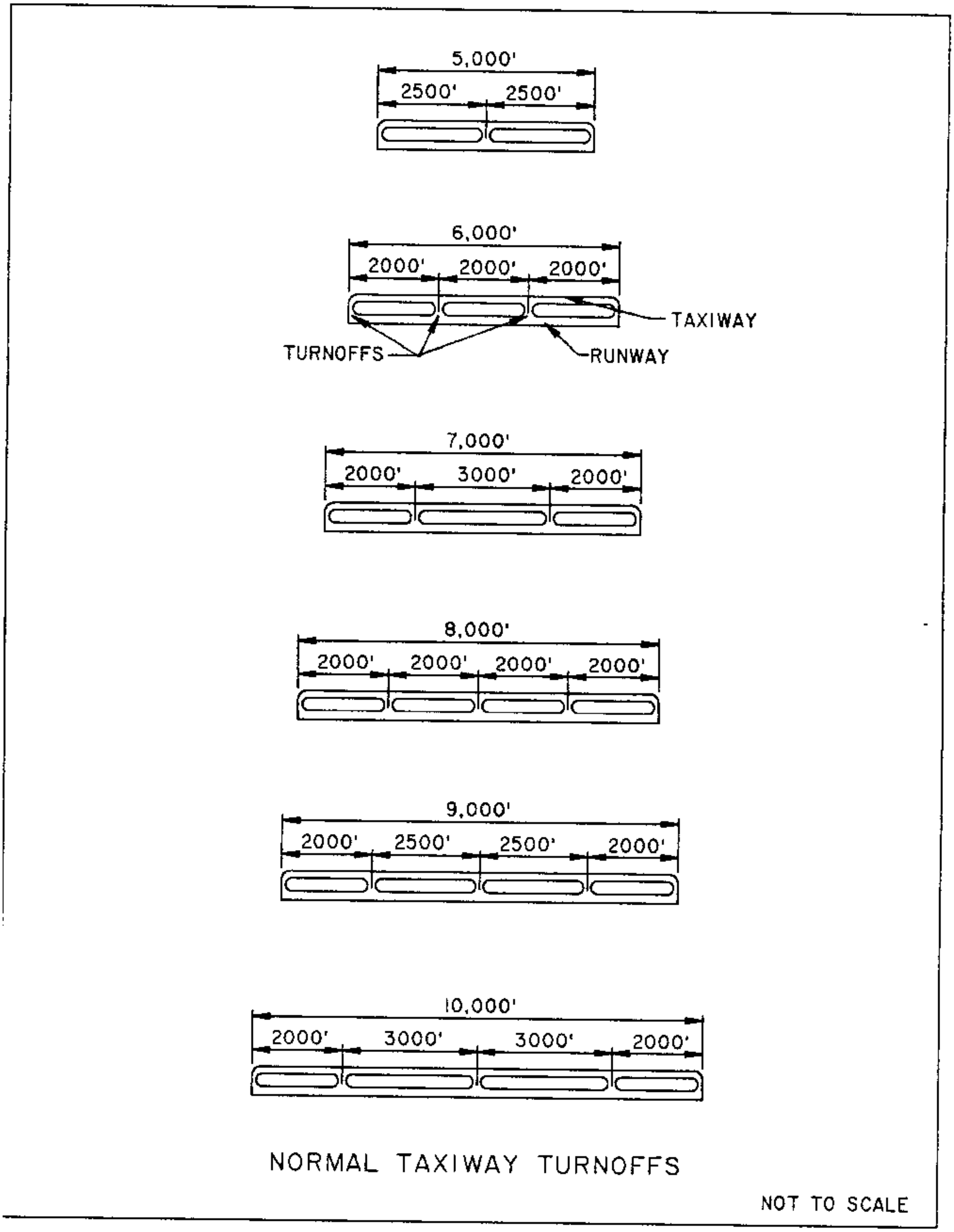
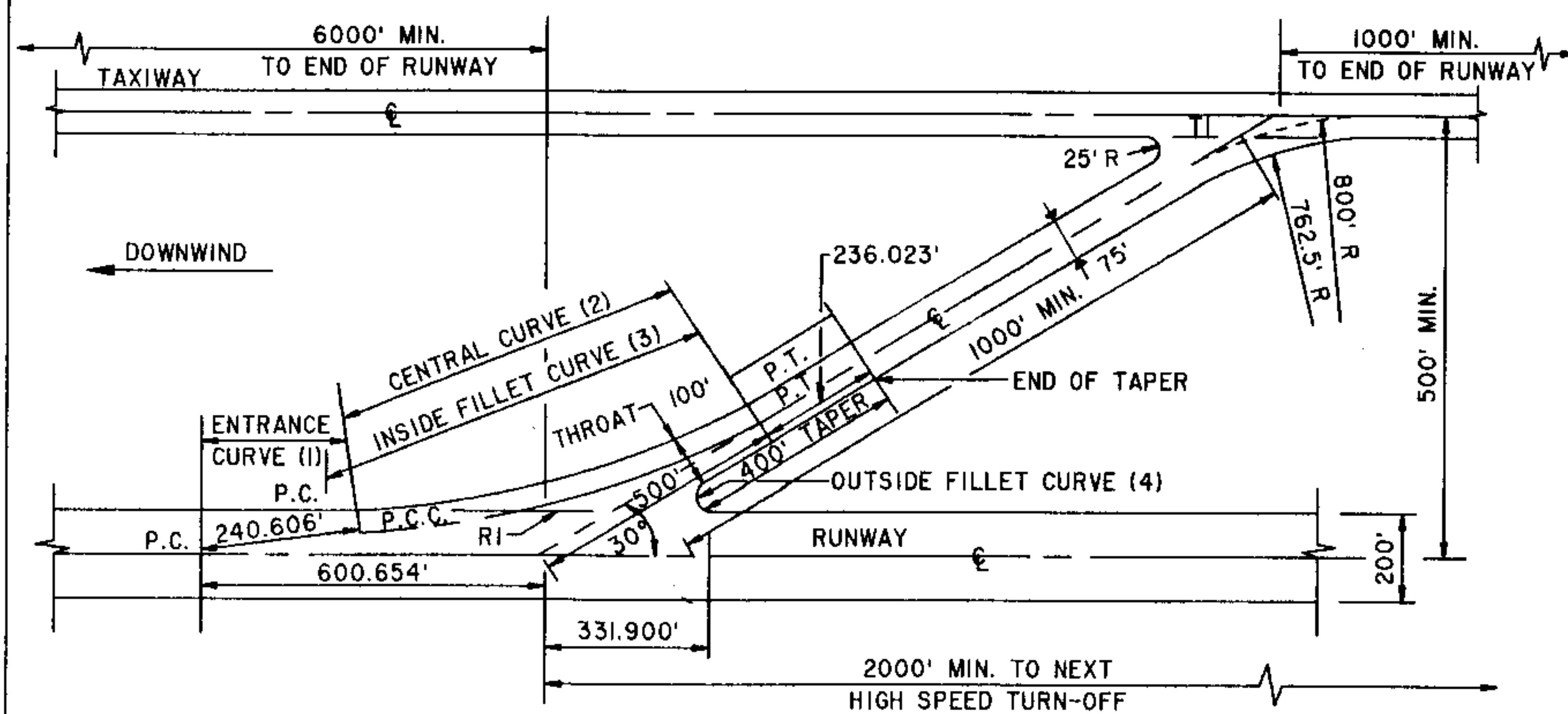


Figure 24
Spacing Requirements--Normal Taxiway Turnoffs



CURVE	Δ	R	T	L_c
NUMBER	DEGREES	FEET	FEET	FEET
1	5°	3206.528	140.000	279.822
2	25°	1826.837	405.000	797.108
3	30°	1548.621	414.952	810.856
4	147°	25.000	86.003	64.395

NOTES:

1. EDGE OF PAVEMENT CURVE (3) SHALL TERMINATE AT, OR BEYOND, THE CENTRAL CURVE.
2. FOR TAXIWAY WITH GREATEST USE ELEVATION AT TI MUST NOT BE MORE THAN 5 FEET ABOVE ELEVATION AT RI.

NOT TO SCALE

Figure 25
Typical High-Speed Turnoff

c) High-Speed Taxiway Turnoffs. Provide one or more high-speed turnoffs for fixed-wing aircraft if operational conditions permit and traffic studies indicate the requirement. For criteria governing pavement geometry and grades, see Table 11. Because aircraft turning off runways at high speeds (maximum 55 knots) require sufficient length of turnoff taxiway to decelerate to a full stop before reaching the parallel taxiway, the minimum length of turnoff shall be 1000 feet. The angle of turnoff is determined by the existing distance between runway and taxiway and by operational requirements of using aircraft, but in no case shall exceed 30 degrees. For typical configuration, see Figure 24.

TABLE 11
High-Speed Taxiway Turnoff

Item	Criteria
Location	First turnoff: Minimum of 6000 feet from downwind end of runway. Last turnoff: Minimum of 1000 feet from upwind end of runway. Minimum spacing between turnoffs: 2000 feet. High-speed turnoffs shall be located only where the parallel taxiway centerline is at or above elevation of runway centerline, but not by more than 5 feet.
Angle of turnoff	Maximum: 30 degrees.
Length	Minimum: 1000 feet between edges of runway and parallel taxiway measured along turnoff tangent extended.
Width	Throat width: 100 feet tapering to 75 feet at point 400 feet from throat. See Figure 24.
Alinement	Central curve is compounded with entrance curve. See Figure 24.
Longitudinal grades	Same as for intermediate turnoff (see Table 10).
Transverse grades	There shall be no superelevation; however, the turnoff surface is warped from the edge of the runway, having a transverse slope of -1% to -1-1/2%, to the regular cross-section of the parallel taxiway.
Fillets	As shown.
Load-bearing capacity surface and shoulders	Same as for taxiways (see Table 10).
Pavement marking	See NAVAIR 51-50AAA-2.

Section 7: APRONS

7.1 Criteria. Criteria for design of aircraft parking aprons and access aprons are included in this section. The requirement for aircraft mooring eyes and utilities to be included in the service points are included in the parking apron criteria. Aircraft maintenance is performed on the parking apron.

7.2 Aircraft Parking Aprons. Aircraft parking aprons consist of paved areas in proximity to maintenance hangars, to provide parking space, tiedown points, service points, and line maintenance areas for aircraft. The parking apron includes interior and peripheral taxi lanes.

7.2.1 Clearances. Minimum separation distances between parking apron edges and other facilities shall be as follows:

Edge of apron:	To centerline of Class B runway	750 feet.
	To centerline of Class A runway	500 feet.
	To centerline of taxiway	150 feet.

The apron edge should be outside the primary surface.

7.2.2 Pavement. See Table 12. The parking area shall be paved with portland cement concrete to resist fuel and hydraulic fluid spillage. Joint seals shall conform to Federal Specifications SS-S-200, Sealant, Joint, Two Component, Jet-Blast Resistant, Cold Applied for Portland Cement Concrete Pavement, and SS-S-1614, Sealants, Joint, Jet Fuel Resistant, Hot-Applied, for Portland Cement and Tar Concrete Pavements.

7.2.3 Area. The parking apron configuration is dependent upon the local site and operational considerations. Minimum pavement consistent with ready access to both maintenance areas and runways shall be used. See NAVFAC P-80 for aircraft spacing criteria and dimensional data on Navy fixed- and rotary-wing aircraft. Except in the case of long wingspan aircraft, the distance between parking rows is governed by jet blast pattern rather than wingspan. The width of the taxi lane is determined by the maneuvering room required for an aircraft maneuvering under its own power. The minimum safe clearance between maneuvering aircraft and other fixed or moving obstructions is:

Wingspan	Clearance
Over 100 feet	25 feet.
75 to 100 feet	20 feet.
50 to 74 feet	15 feet.
Less than 50 feet	10 feet.

7.2.4 Service Points. See Table 13. Service points shall be provided where jet aircraft other than cargo transport aircraft are parked, with each service point serving two aircraft. Service points are constructed integral with parking apron pavement, and their height shall not exceed 24 inches above pavement surface. A cover to protect utilities outlets from weather shall be provided. Special electrical requirements are as follows:

TABLE 12
Aircraft Aprons (Fixed- and Rotary-Wing Aircraft)

Item	Criteria
Size and configuration:	Variable, consult NAVFAC P-80. As a general rule there are no standard sizes for aprons. They are individually designed to support specific aircraft uses. The detailed dimensions are determined by the number and type of aircraft involved, the function of the apron, and the maneuvering characteristics of the aircraft and the degree of unit integrity to be maintained. Other determinants are the physical characteristics of the site, relationship of the apron area to other airfield facilities and the objective of the master plan.
Grades:	0.5% minimum. (For rigid pavement only 1.5% maximum. and for small areas.) Engineering analysis occasionally may indicate a need to vary these limits. Avoid surface drainage with numerous or abrupt grade changes which can cause flexing of aircraft or rotor blades or other structural damage.
Width of shoulders:	25 feet for rotary wing. 50 feet for fixed wing.
Longitudinal grade of shoulders:	Variable. Conform to longitudinal grade of the abutting primary pavement.
Transverse grade of shoulders:	
Class A Runway	5.0% first 10 feet followed by 2.0% minimum to 4.0% maximum.
Class B Runway	2.0% minimum. Unpaved shoulders may 4.0% maximum. be increased to 5.0% for the first 10 feet. Paved shoulders for B52 aircraft will have transverse grades between 1.5% and 2.0%.

TABLE 12 (Continued)
Aircraft Aprons (Fixed- and Rotary-Wing Aircraft)

Item	Criteria	
Rotary-Wing	5.0% first 10 feet followed by 2.0% minimum. 4.0% maximum.	
Rotary-Wing Aircraft:		
Clear taxi lane (interior)	2.5 X Rotor diameter for a diameter less than 50 feet. 2.0 X Rotor diameter for all others.	Use rotor diameter of largest helicopter normally using the apron. When a taxi lane on an apron has a dual use with fixed-wing aircraft, adjust the width appropriately.
Clear taxi lane (perimeter)	75 foot width for a Rotor diameter less than 50 feet. 1.5 X Rotor diameter plus an additional 20 feet from centerline of taxiway to apron edge for Rotor diameter greater than 50 feet.	
Hoverlane	2.5 X Rotor diameter.	Diameter of largest helicopter usually using the apron.
Clearance to fixed or mobile obstacles:		
Class A Runway	75 feet.	Measured from rear and side of apron. Distance to other aircraft operational pavements may require a greater clearance.
Class B Runway	100 feet.	
Rotary-Wing	75 feet.	
	100 feet.	For aprons regularly servicing H-53 helicopters.

TABLE 12 (Continued)
Aircraft Aprons (Fixed- and Rotary-Wing Aircraft)

Item	Criteria
Grades in cleared area beyond shoulders to fixed or mobile obstacles:	
Class A and B Runways	10.0% maximum.

TABLE 13
Aircraft Parking Apron
Service Point Requirements

Item	Criteria
Tiedowns	Provide mooring eyes over entire parking apron including peripheral taxi lane, unless peripheral lane happens to be flexible pavement. Spacing (on centers): 12'6" x 15'0". For details of mooring eyes and typical installations, see MIL-HDBK-1021/4, Rigid Pavement Design for Airfields.
Service points	For location see NAVFAC P-80. For additional requirements see paragraph 7.2.4. Each service point provides the following when authorized: Two 100 ampere, 115/200 volt, 3 phase, 4 wire, 400 hertz aircraft service cables. Two 100 ampere, 480 volt, 3 phase, 4 pole, 60 hertz receptacles. Fourth pole is for equipment grounding connection. Two 20 ampere, 125 volt, 1 phase, 2 pole, 3 wire duplex receptacles. Serve from a 480-120/240 volt, 60 hertz transformer. Engine starting air, 180 lb/min at both 45 and 75 psi, with a 3-inch hose outlet.
Grounding receptacles	Electrical. None Required. Static. Aircraft tiedowns (mooring eyes) will provide adequate static grounding with resistance well below 10,000 ohms.

a) Receptacles for ground support equipment shall conform to Military Specification MIL-C-22992, Connector, Plugs and Receptacles, Electrical, Waterproof, Quick Disconnect, Heavy Duty Type, (Class L) and Military Standard MIL-STD-90555, Connector, Receptacle, Electrical, Wall Mounting Class L (Power Source Receptacle), Part No. MS90555C44150S.

b) Cables for 400 hertz service to the aircraft shall be connected directly to the circuit breakers at the service points. The length of the cables will be determined by the type of aircraft to be served. The power supplied to the aircraft shall be in accordance with MIL-STD-704, Aircraft Electric Power Characteristics.

7.2.5 Tiedown Mooring Eyes. For location, see Table 13. For details see MIL-HDBK-1021/4.

7.3 Aircraft Access Apron. Access aprons provide access to the hangars from the parking apron, and allow free movement of aircraft to the various hangar maintenance facilities. The paved area between hangars that is not a taxiway or parking area is included in the access apron. See Figure 26 for typical access apron plans.

7.3.1 Pavement. See Table 14 for design details. The requirements and criteria for access aprons are applicable equally to fixed- and rotary-wing aircraft.

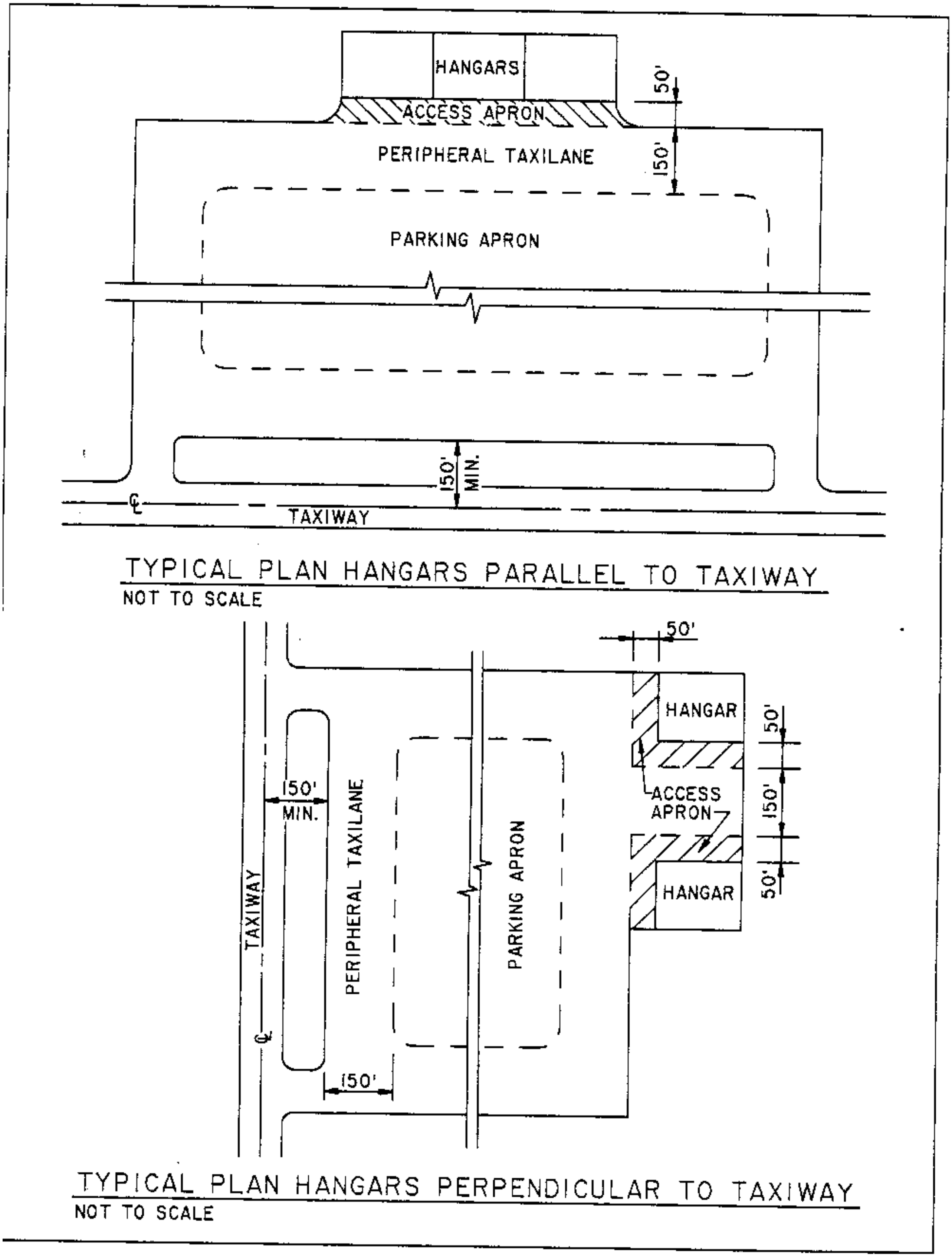


Figure 26
Typical Access Apron Plans

TABLE 14
Access Apron Design Criteria

Item	Criteria
Load-bearing capacity	Design strength shall be same as for hangar floor.
Surfacing:	
Type	Portland cement concrete.
Fuel spillage resistance	Entire apron to be resistant to effects of fuel spillage.
Smoothness	Maximum irregularity shall be 1/8 inch in 10 feet.
Size:	
Area requirements	Minimum of 50 feet wide, length at least as long as the width of the hangar door. See Figure 26 for typical plans.
Grades	Smooth continuation of adjacent parking apron and hangar floor. With maximum of 1.5% and minimum of 0.5% in any direction.
Drainage	See MIL-HDBK-1005/3.
Shoulders:	
Width	Same as apron shoulders.
Treatment	Same as for apron shoulders.
Tiedown anchors	None required on access apron.

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Section 8: OTHER AIRFIELD PAVEMENTS

8.1 Configuration and Grading Criteria. Configuration and grading criteria for other airfield pavements are generally the same as for aprons. See Table 12.

8.2 Aircraft Washrack. Aircraft washracks are provided at all air stations for cleaning of aircraft in conjunction with periodic maintenance. Maximum use should be made of existing pavements where curbing can be provided, drainage adjusted as necessary, and other required facilities provided to make a usable washrack. The size of the washrack is determined by the type of aircraft at the station.

8.2.1 Location. Locate washrack in the hangar area and contiguous to aircraft parking or access apron. The utility control building shall be located a sufficient distance from the washrack to preclude fire hazards to aircraft on the washrack.

8.2.2 Design Requirements. See NAVFAC P-272, DD-1291729, Aircraft Washracks.

a) Pavement. The pavement shall be portland cement concrete designed to the same strength and quality as adjacent apron or taxiway. Provide a high friction finish and slope at 1.5 percent to drains.

b) Wash Water. Wash water shall be provided at each utilities service outlet. Since detergent used for aircraft cleaning is formulated to be used with cold water, hot water supply is an option dependent on geographic location.

c) Wastewater Collection. See MIL-HDBK-1005/9, Industrial and Oily Wastewater Control, Section 2, paragraph 2.5.6.

d) Wastewater Treatment. For treatment requirements, see MIL-HDBK-1005/8.

e) All utilities emanate from the utilities control building. It houses utility controls for the washrack, storage space for equipment, and materials used at the washrack, sanitary facilities, and office space for personnel assigned. Sanitary facilities shall be provided only if not already available within 1000 feet.

f) A detergent storage tank may be located at ground level or below ground, dependent on climatic conditions. The detergent mixing tank, if used, shall be provided with mechanical or air mixing facilities. Metered water and detergent connections shall be made to the mixing tank inside the utilities control building. Detergent piping shall provide for delivery of 2 gallons per minute of detergent at 15 pounds per square inch.

8.3 Aircraft Rinse Facility. An aircraft fresh water rinse facility is a taxi-through, treadle-operated, high-pressure deluge system.

8.3.1 Location. Rinse facilities shall be located for ease of use by aircraft returning from flight and en route to the parking area. Location shall be as close to the hangar area as is practical.

8.3.2 Design Requirements. Facility Plate No. 116-15 indicates facility layouts for four types of aircraft and details of nozzles and outriggers.

a) Provide water at 100 to 150 pounds per square inch at the spray nozzles for each type of pad. A booster pump and storage tank shall be provided to maintain specified quantity and pressure of water.

b) Provide drainage into sewer system. See MIL-HDBK-1005/9. Consider use of oil water separator and waste oil holding tank on drain line.

c) Pavement shall be portland cement concrete designed to the same criteria as the aircraft washrack (paragraph 8.2).

d) The angle of water impinging on engine air intake is critical. Adjustable nozzles shall be used and regulated to prevent water from being sprayed into the engine intake.

e) Rotary-wing aircraft require the use of 10 to 12 gpm 15-degree flat spray pattern nozzles to overcome helicopter blade downdraft along with 30-degree and solid spray nozzels. Fifty gpm solid stream nozzles should be used for outrigger or edge of pavement placement to impinge on top of helicopter blades and fuselage. See Facility Plate No. 116-15, sheet 1 of 8.

f) Fixed-wing VP type aircraft should use a 15-degree flat spray nozzle at 10 to 12 gpm throughout the facility. Outrigger or edge of pavement 50 gpm solid stream nozzles may be needed to impinge on tail sections. See Facility Plate No. 116-15, sheet 2 of 8.

g) Fixed-wing VA and VF type aircraft require 30-degree flat spray nozzles at 10 to 15 gpm. See Facility Plate No. 116-15, sheet 3 of 8.

h) Tilt rotor (V-22) aircraft require a combination of 15- and 30-degree flat and solid spray nozzles. See Facility Plate No. 116-15, sheet 4 of 8.

8.4 Aircraft Compass Calibration Pad. An aircraft compass calibration pad provides a suitable area in which to calibrate aircraft compasses. Type I pad is for use with a magnetic compass calibration set. Type II pad is for use with or without the magnetic compass calibration set. It includes a compass rose and turntable to accommodate aircraft which are not adaptable to the com-pass calibration set.

8.4.1 Location. The compass calibration pad shall be located in an area as free as possible from local magnetic disturbances. The direction and uniformity of the earth's field shall be determined prior to use of the area for compass swinging. Magnetic interference shall be checked annually thereafter. Any changes in physical features of the site that might result in a magnetic disturbance, necessitates an immediate resurvey to determine if the uniformity of the earth's field has been adversely affected. The magnetic compass calibration set includes equipment and technical manual for making an area magnetic survey. In this survey, the direction and strength of earth's magnetic field are measured at various points in the selected swing site to determine if the earth's field is sufficiently uniform to ensure accuracy of the swing.

8.4.2 Pavement. The pavement shall be non-reinforced portland cement concrete, and shall have load-bearing capacity equivalent to the taxiway servicing the pad in order to support the most critical wheel loading. A 10-foot paved shoulder, sloped to drain away from pad and access taxiway, shall be provided along with an unpaved portion. See Table 15 and Figure 27 for additional details.

8.4.3 Access Taxiway. A paved access taxiway, having a minimum width of 75 feet, shall be provided. The minimum distance from the centerline of the nearest primary taxiway to the center of the compass calibration pad shall be not less than 275 feet. The access taxiway shall be oriented so as to facilitate moving the aircraft onto the calibration pad directly on a north-south heading.

8.4.4 Electrical Requirements. Magnetic compass (MC) calibration sets require an alternating current power source at the pad. The MC-2 requires alternating current single-phase electric power, 115 + 10 volts, 400 + 10 hertz with a second harmonic less than 0.575 volt alternating current and maximum input of 200 volt-amperes. Consult technical manual of the set to be used for detailed criteria.

8.4.5 Pavement Markings. See Figure 27 for method of delineating the north-south line on Type I pads and marking the compass rose on Type II pads.

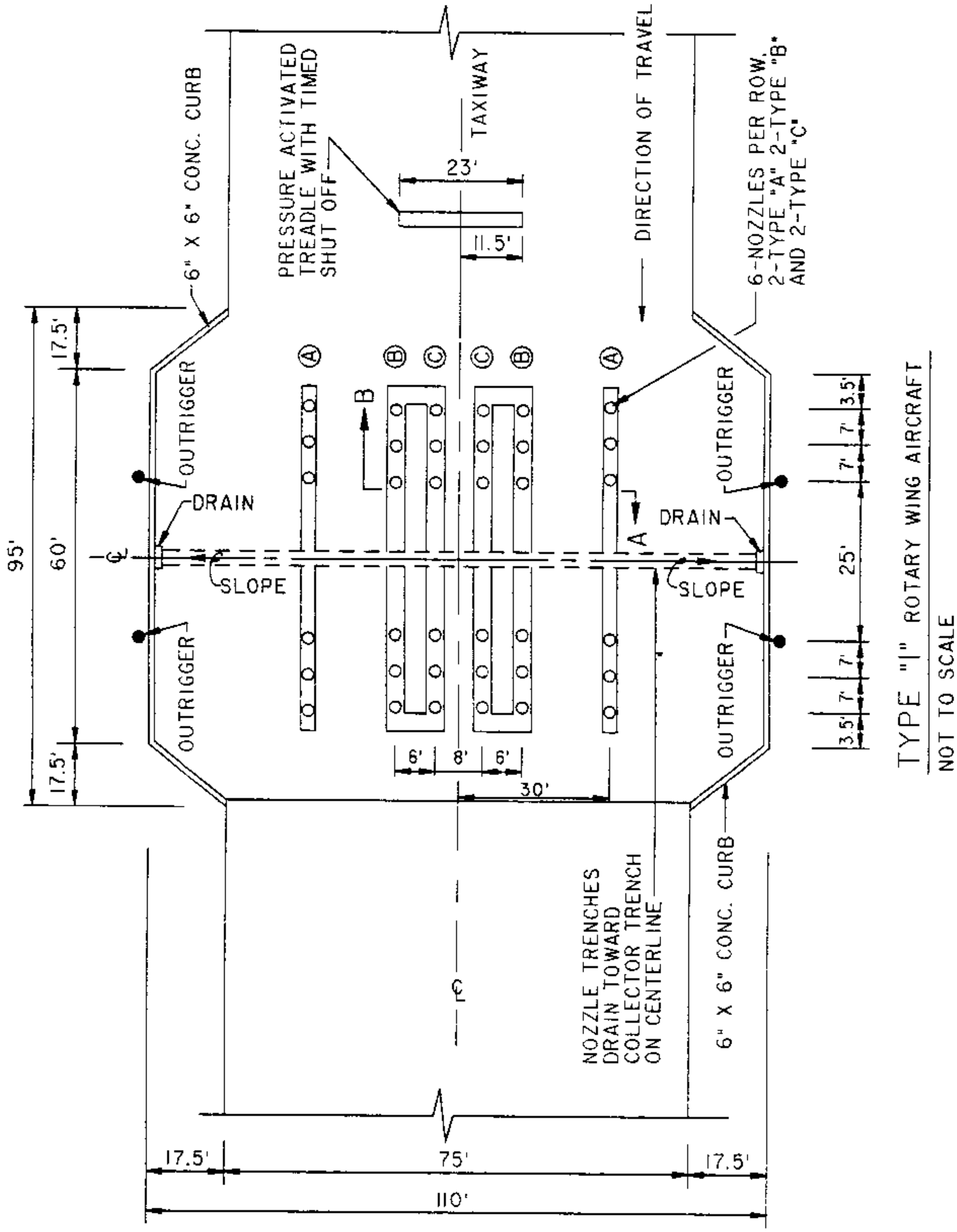
8.5 Arming and De-arming Pad. Arming and de-arming pads are used for the loading and unloading of aircraft ordnance.

8.5.1 Location. Arming and de-arming pads shall be located adjacent to runway thresholds. See Figure 28. Prior to the construction of any arming and de-arming pad, local field measurements shall be taken to ensure that the location is electromagnetically quiet. To avoid potential electromagnetic interference from taxiing aircraft, pads shall be located on the side of a runway opposite the parallel taxiway.

8.5.2 Pavement. For specific requirements, see Table 16. An all-weather access road, to accommodate ordnance handling vehicles, shall be provided.

8.6 Line Vehicle Parking. Line vehicle parking areas are provided for parking of mobile station-assigned and squadron-assigned vehicles and equipment. For fire and crash vehicle parking, see NAVFAC P-80. For parking of squadron equipment, see also MIL-HDBK-1028/1, Aircraft Maintenance Facilities.

8.6.1 Location. Select parking areas that permit optimum efficiency in use of the equipment. Locations shall conform to lateral safety clearance requirements of existing or planned airfield pavements. See Figure 29 for typical site plan.



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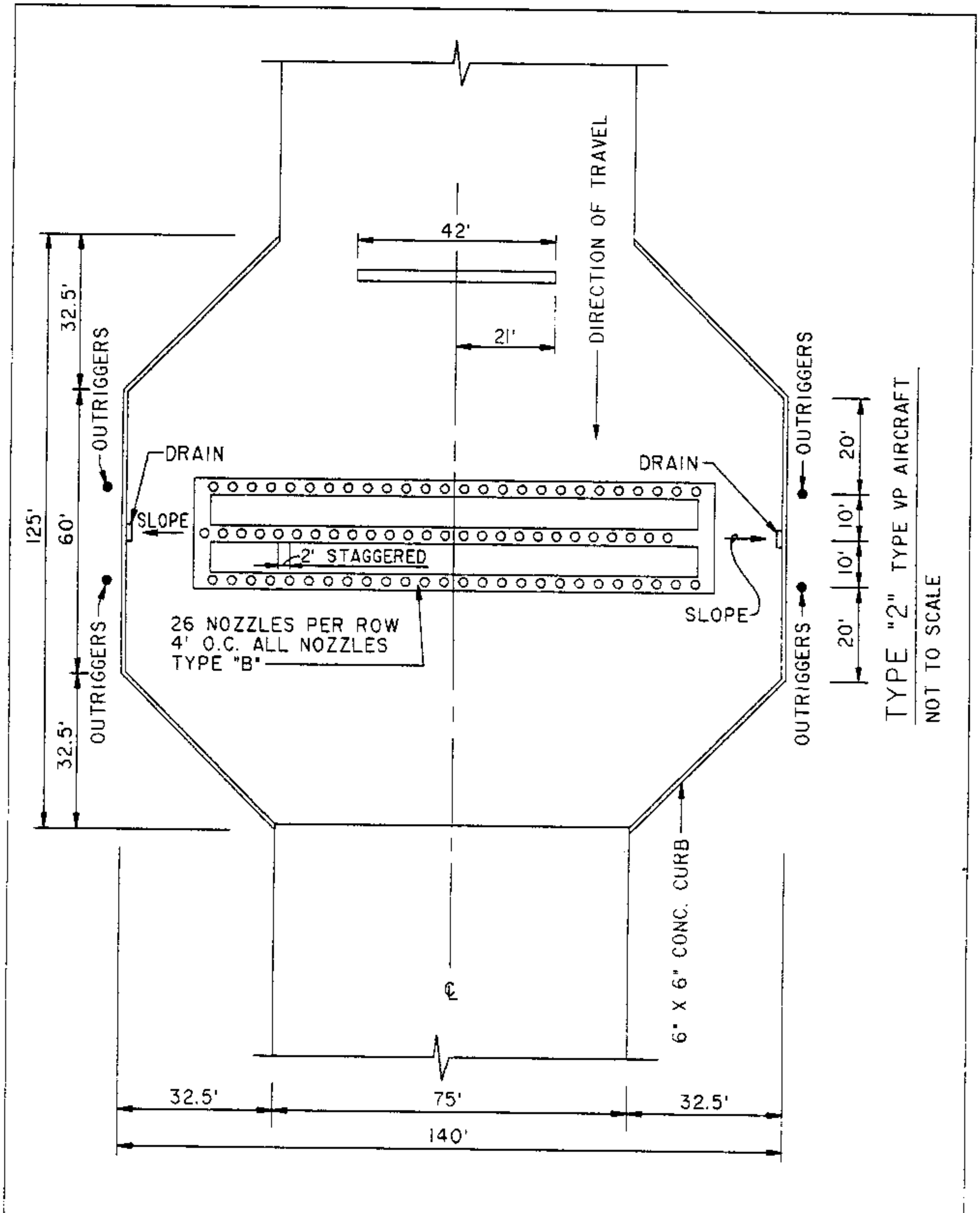

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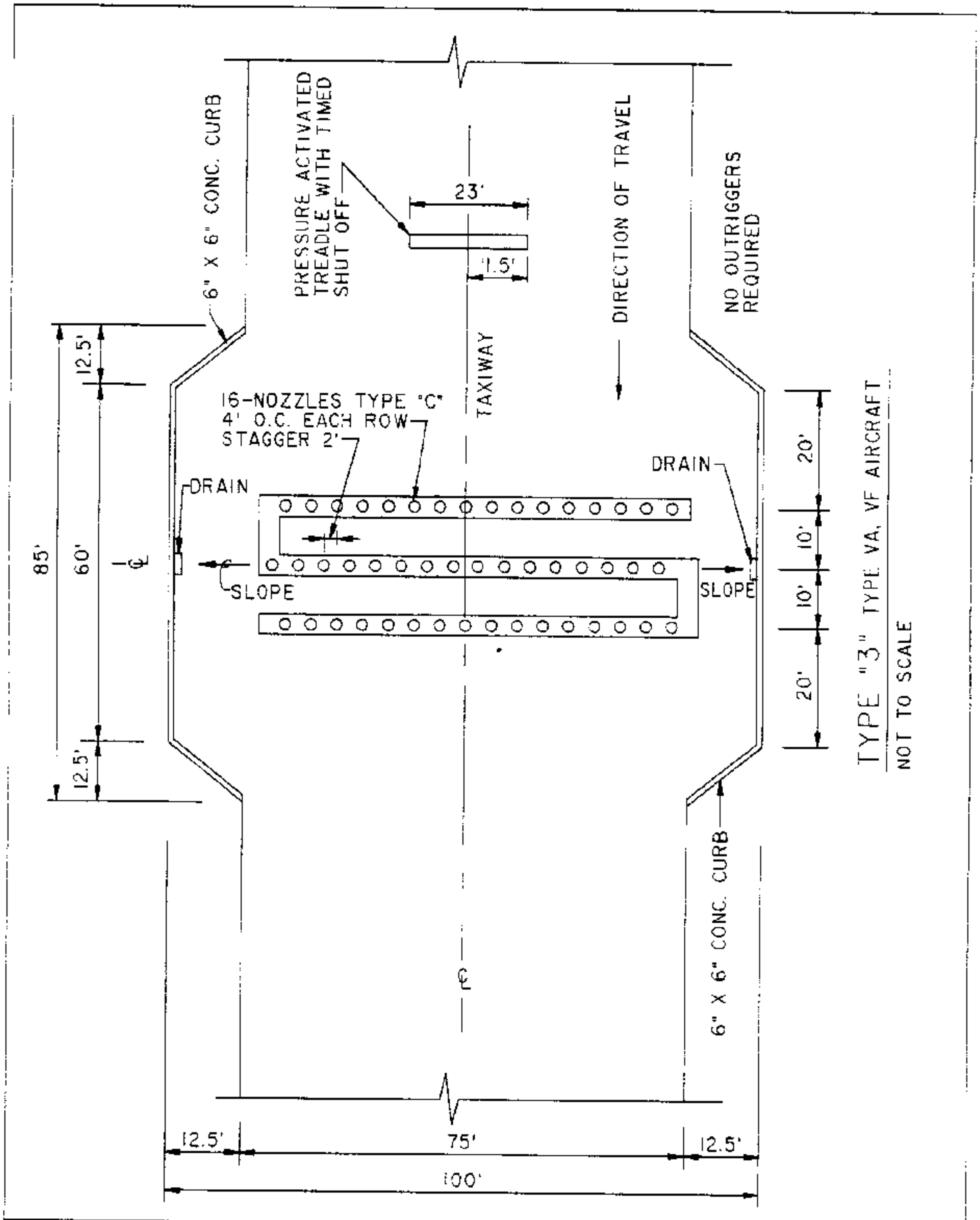

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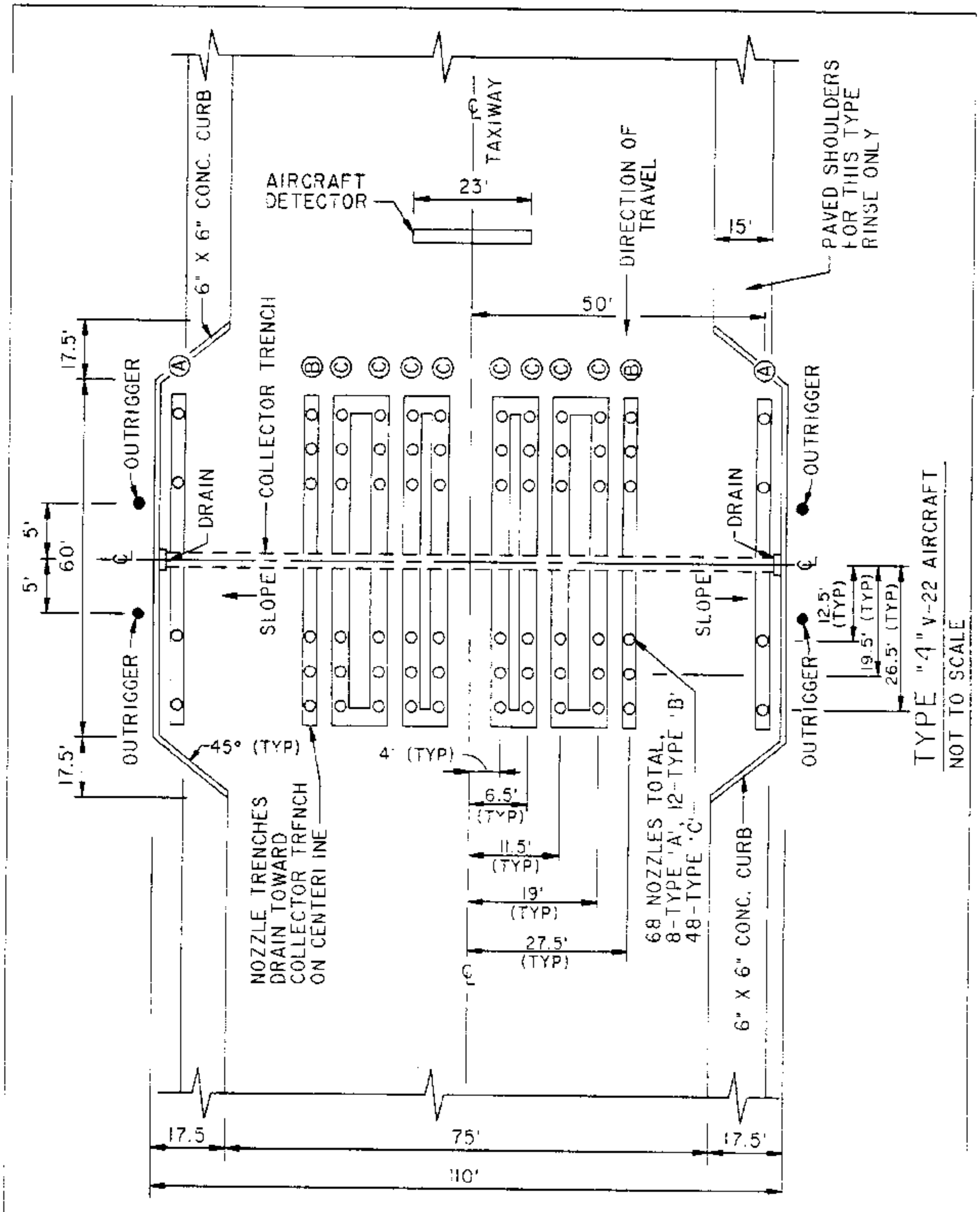
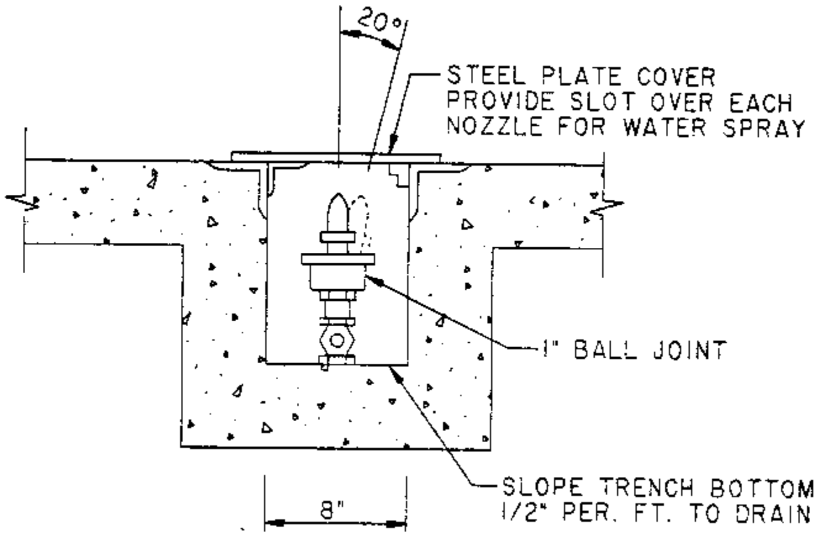
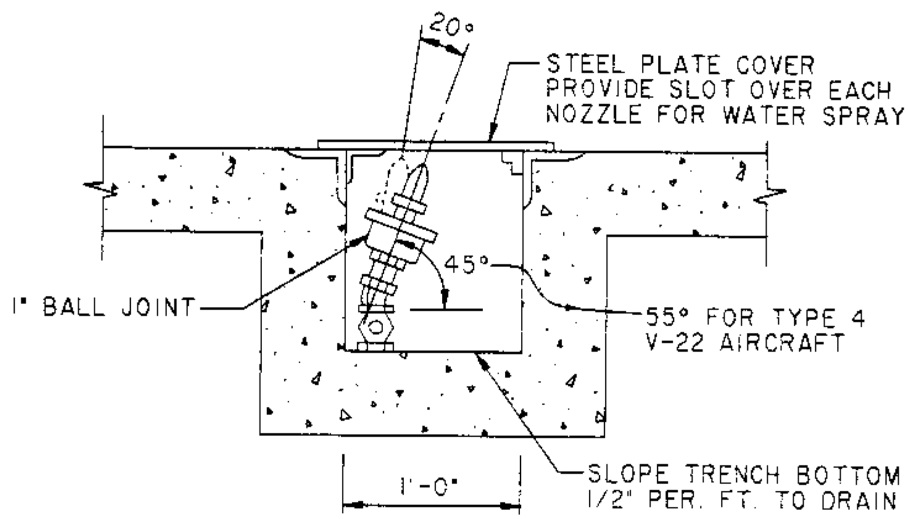


TITLE	DATE	FACILITY PLATE NO.	SHEET
AIRCRAFT RINSE FACILITY	DEC 1989	116-15	4 OF 8



SECTION "B" FOR ALL Ⓒ NOZZLES AND Ⓑ NOZZLES FOR TYPES 1 & 2

NOT TO SCALE



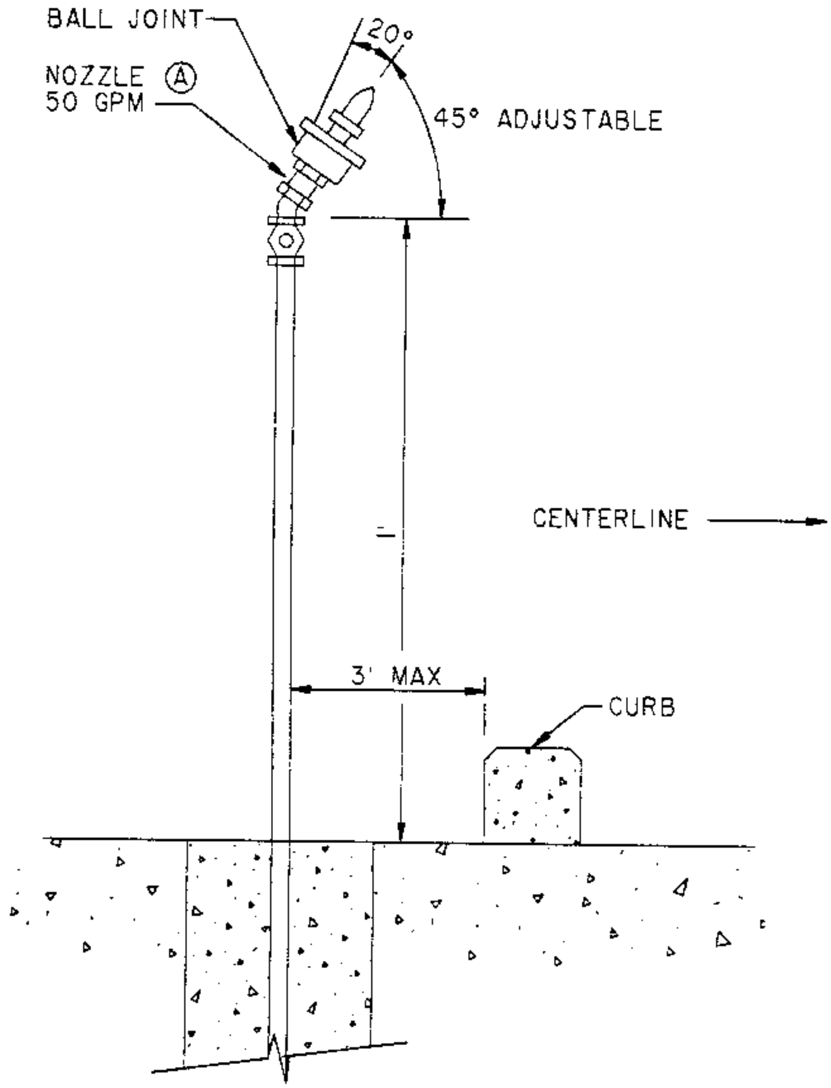
SECTION "A" FOR ALL Ⓐ NOZZLES & TYPE 4 FOR Ⓑ NOZZLES

NOT TO SCALE

NOZZLE SCHEDULE

- Ⓐ SOLID STREAM
- Ⓑ 15° FLAT SPRAY
- Ⓒ 30° FLAT SPRAY

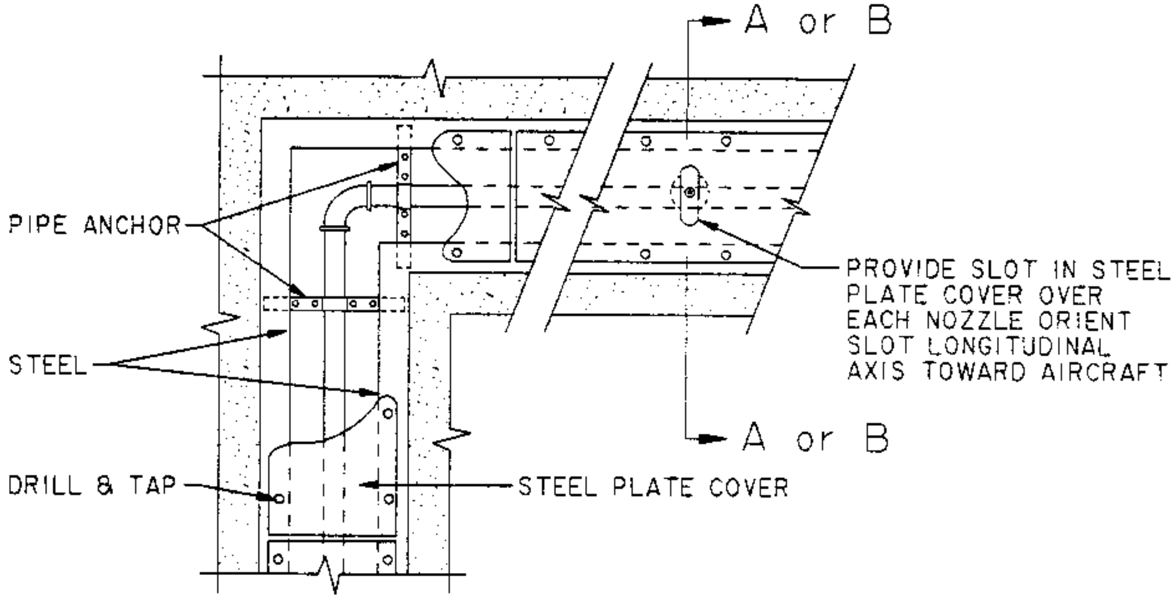
TITLE	DATE	FACILITY PLATE NO.	SHEET
AIRCRAFT RINSE FACILITY	DEC 1989	116-15	5 OF 8



OUTRIGGER NOZZLE DETAIL

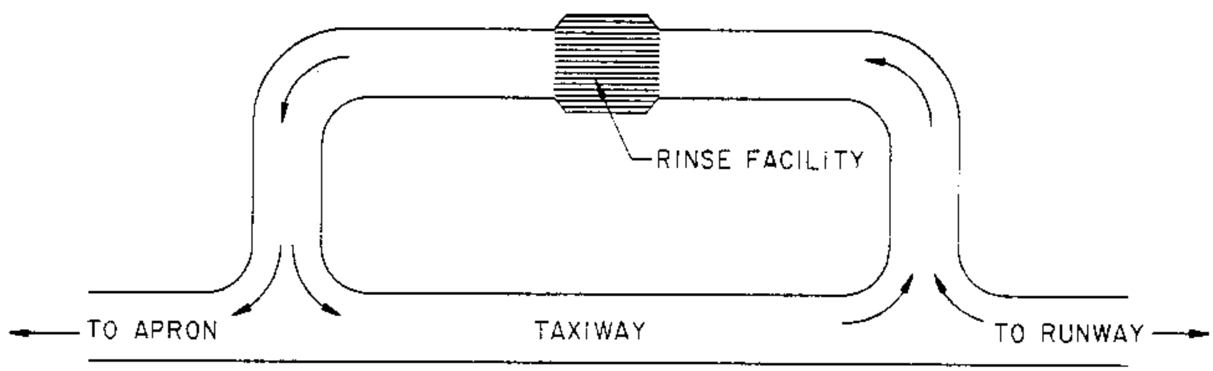
NOT TO SCALE

TITLE	DATE	FACILITY PLATE NO.	SHEET
AIRCRAFT RINSE FACILITY	DEC 1989	116-15	6 OF 8



TYPICAL PLAN

NOT TO SCALE



TYPICAL SITE PLAN

NOT TO SCALE

TITLE AIRCRAFT RINSE FACILITY	DATE DEC 1989	FACILITY PLATE NO. 116-15	SHEET 7 OF 8

NOTES

PLUMBING REQUIREMENTS

COLD WATER (PROBABLE MAXIMUM FLOW RATE)

TYPE FACILITY	FLOW RATE (G.P.M.)
1	632
2	1136
3	720
4	1016

ABOVE RATES DO NOT INCLUDE REQUIREMENTS FOR FIRE PROTECTION

ELECTRICAL REQUIREMENTS

POWER

TYPE FACILITY	PUMP HP	CONNECTED LOAD	ESTIMATED DEMAND
1	75	56 KW	54 KW
2	150	112 KW	98 KW
3	100	75 KW	63 KW
4	125	95 KW	21 KW

AREAS

TYPE FACILITY	
1	1093 S.Y.
2	1710 S.Y.
3	910 S.Y.
4	1093 S.Y.

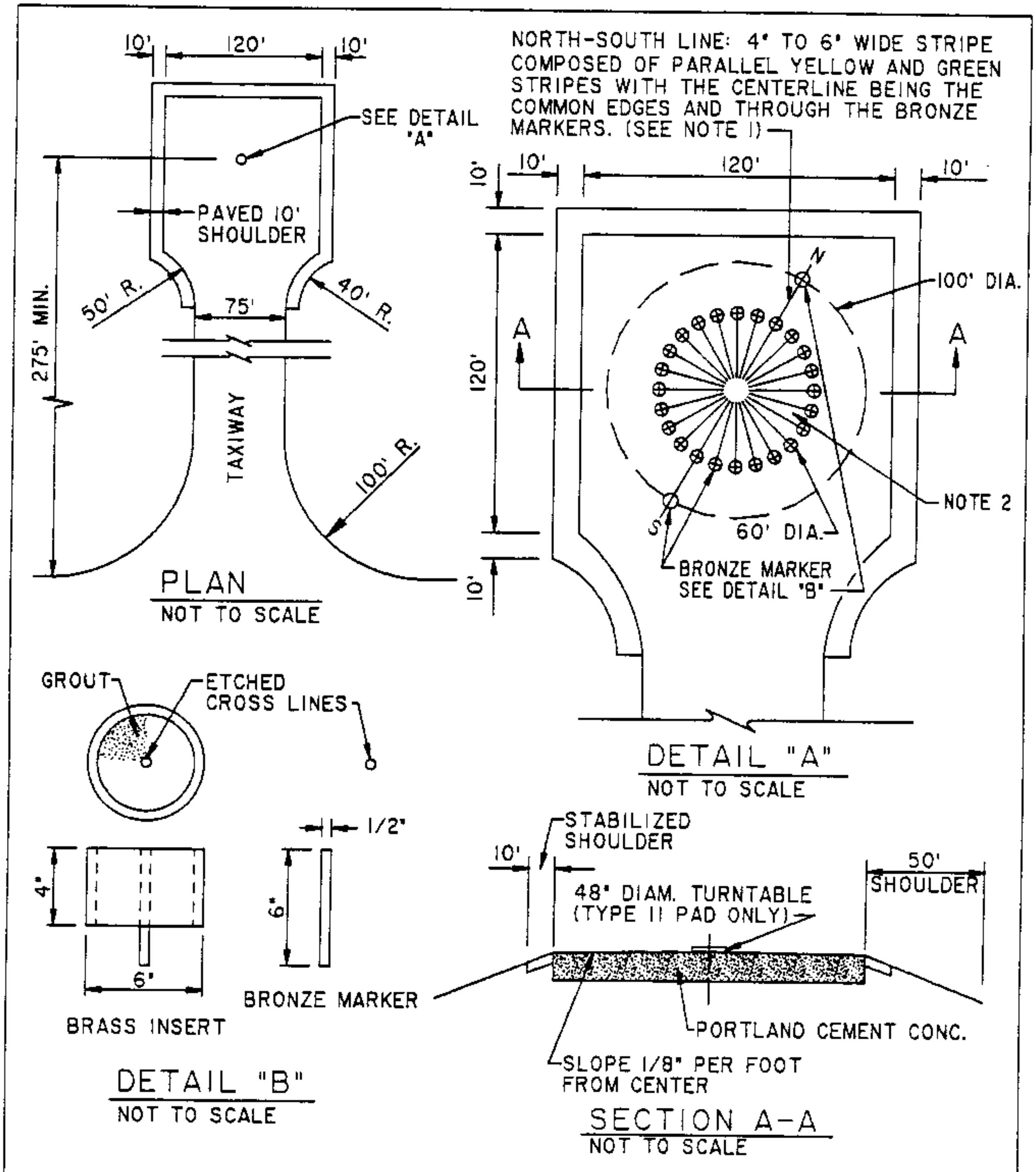
TITLE	DATE	FACILITY PLATE NO.	SHEET
AIRCRAFT RINSE FACILITY	DEC 1989	116-15	8 OF 8

TABLE 15
Aircraft Compass Calibration Pad Design Criteria

Item	Criteria	
Location:		
Accessibility	Must be accessible, free of nearby traffic, and have sufficient space for the largest aircraft using the facility to be moved in headed toward magnetic north.	
Magnetic influences	For maximum accuracy, earth's magnetic field in the area should be uniform in both magnitude and direction. Tolerances prescribed are required to ensure a swing accuracy of 0.2 degree.	
Lateral clearances	Maintain following minimum clearances from center of pad:	
	To nearest portion of building containing any magnetic material such as steel and iron	600 ft.
	To nearest edge of railroad tracks	600 ft.
	To dc power line and/or equipment	1000 ft.
	To edge of aircraft and vehicle parking areas	275 ft.
	To ac power line and/or equipment	600 ft.
	To underground electric power line	500 ft.
	To overhead steam lines	600 ft.
	To underground metal conduits and piping	225 ft.
	To centerline of nearest primary taxiway or towway	275 ft.
Pavement:		
Type	Portland cement concrete without reinforcement.	
Load-bearing capacity	See MIL-HDBK-1021/2.	
Special construction requirements	All construction materials shall be free of ferrous and other magnetic substances.	
Shoulders:		
Slope treatment	Provide 50-foot wide shoulders with transverse grade maximum 4.0% and minimum 2.0%. Pave the inner 10-foot shoulders in same manner as first 10 feet of runway shoulders from runway edge.	
Size	See Figure 27.	

TABLE 15 (Continued)
Aircraft Compass Calibration Pad Design Criteria

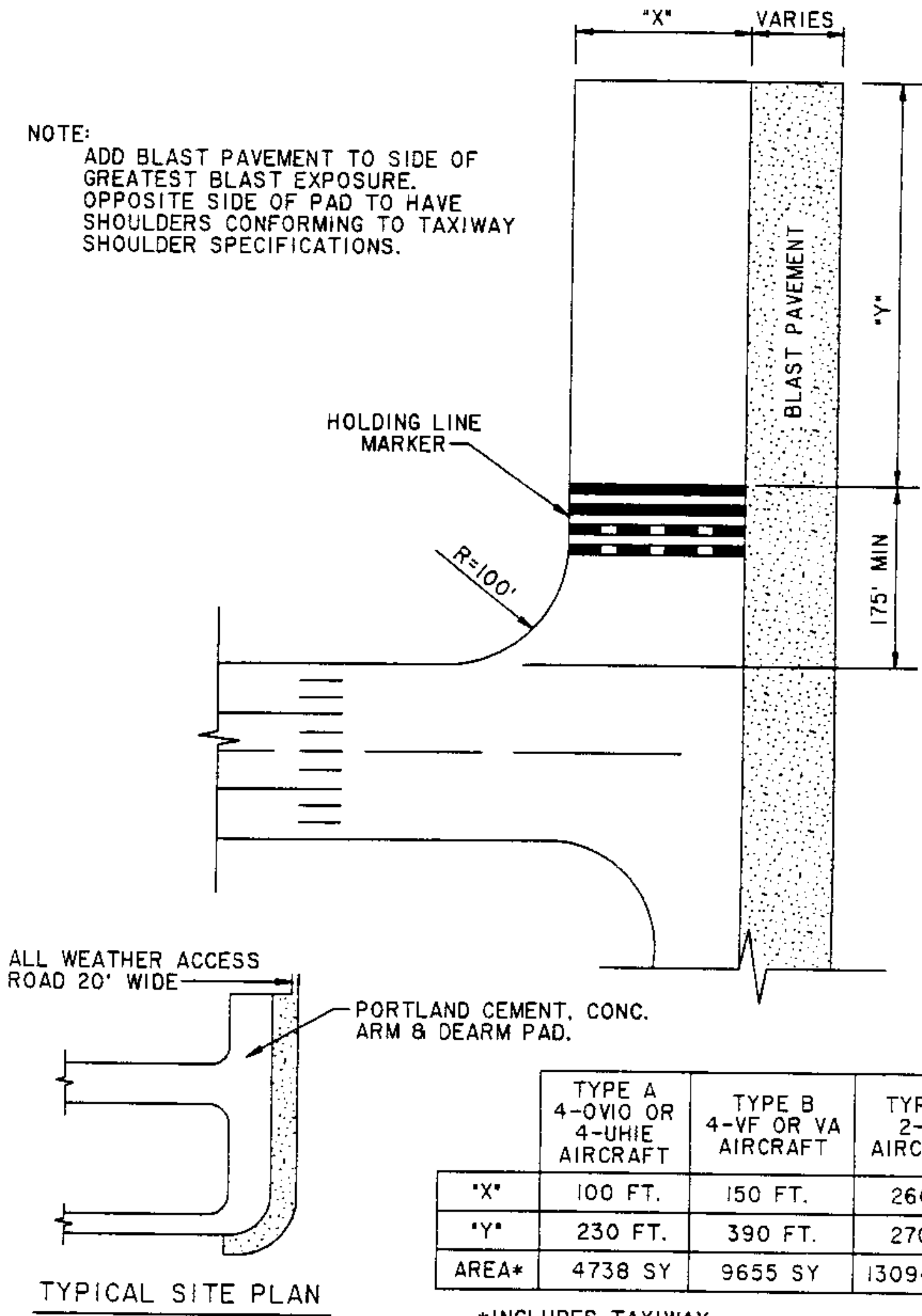
Item	Criteria
Control points	For Type I pad: Set control points to establish magnetic north-south line. Control points shall consist of brass inserts into which bronze markers are grouted in accurate alignment. For Type II pad: In addition to the control points for the Type I pad, provide 24 control points on a 60-foot diameter circle, spaces every 15 degrees, beginning with magnetic north. These markers locate the centerlines for painting radial stripes to the perimeter of the circle. Each radial line shall be two colors and be a minimum of 4 inches and a maximum of 6 inches wide. Colors shall be yellow and green. The centerline of the two colors shall be on the line scribed during the magnetic survey.
Turntable	The Type II pad shall have installed a 150,000 pound capacity turntable, for single or dual wheels.



NOTES: 1. FOR TYPE I PAD: TWO MARKERS ARE LOCATED ON CIRCUMFERENCE OF 100-FOOT DIAMETER CIRCLE, LINE JOINING POINT OF INTERSECTION OF ETCHED LINES ON MARKERS INDICATED N-S LINE.

2. FOR TYPE II PAD: SAME AS TYPE I WITH ADDITION OF 24 MARKERS ON 60-FOOT DIAMETER CIRCLE AND RADIAL STRIPES PER TABLE 16.

Figure 27
Typical Compass Calibration Pad Plan



	TYPE A 4-OV10 OR 4-UH1E AIRCRAFT	TYPE B 4-VF OR VA AIRCRAFT	TYPE C 2-VP AIRCRAFT
"X"	100 FT.	150 FT.	260 FT.
"Y"	230 FT.	390 FT.	270 FT.
AREA*	4738 SY	9655 SY	13094 SY

*INCLUDES TAXIWAY

NOT TO SCALE

Figure 28
Arming And De-Arming Pad

TABLE 16
Aircraft Arming and De-arming Pad Design Criteria

Item	Criteria
Load-bearing capacity	See DM-21.03, Flexible Pavement Design for Airfields, MIL-HDBK-1021/2/4.
Surfacing	Type: Portland cement concrete. Smoothness: Maximum irregularity 1/8 inch in 10 feet in any direction. Grades: Slope to drain away from runway. Maximum: 1.5%. Minimum: 0.5%.
Blast pavement	Required on side normally subjected to jet blast. Remaining sides of pad to have 50-foot shoulder conforming to taxiway shoulder criteria.
Access road	Width: 20 feet. Type: All-weather. See ARMY TM-5-822-2/AFM 88-7, CHAP 5, General Provisions and Geometric Design for Roads, Streets, Walks, and Open Storage Areas. Location: Conform to highway clearance requirements where road crosses runway approach zone.

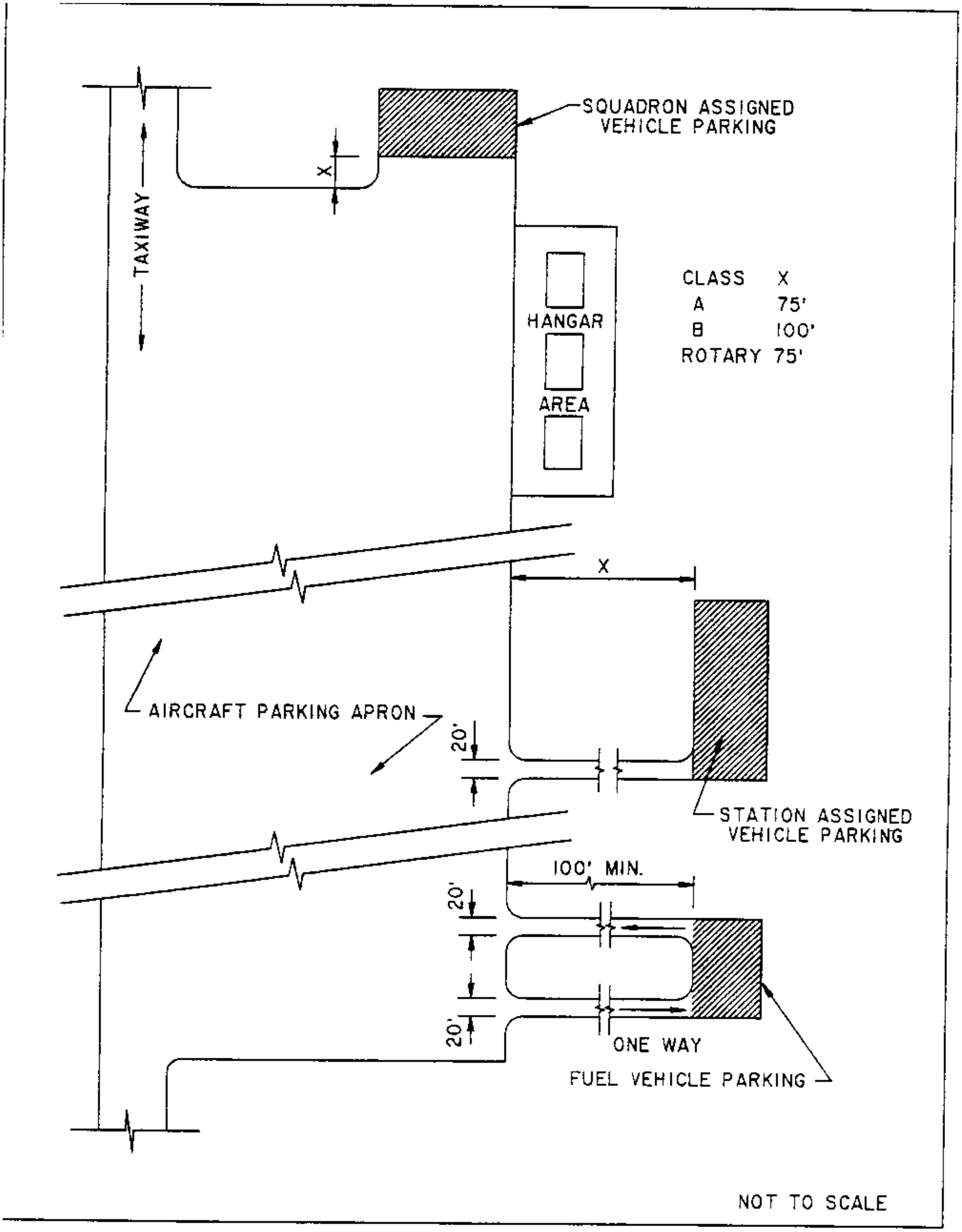


Figure 29
Typical Site Plan Vehicle Parking

a) Station-Assigned Vehicles. Provide parking areas adjacent to the aircraft fire and rescue station for fire and rescue vehicles. Where the fire and rescue station location does not permit immediate access to runways, a separate hardstand near the runway is required. Provide parking areas for other station-assigned vehicles adjacent to the parking apron.

b) Squadron-Assigned Vehicles. Provide parking areas adjacent to hangar access for mobile electric power plants, oxygen trailers, utility jeeps, tow tractors, and other ground support equipment.

c) Refueling Vehicles. Provide a central paved parking area for refueling trucks and trailers at least 100 feet from nearest edge of the aircraft parking apron. See NAVFAC DM-22, Petroleum Fuel Facilities.

8.6.2 Area Required. Parking area sizes are shown in Table 17.

8.6.3 Surfacing. Line parking areas shall be paved with flexible or rigid pavement; base the selection on minimum construction cost. Surfaces shall be graded to drain and shall have no irregularities greater than + 1/8 inch in 10 feet for rigid pavement and + 1/4 inch in 10 feet for flexible pavement. Design pavements for vehicle parking areas described above to support a 34,000-pound twin axle loading.

8.6.4 Shelter. Line vehicles may be housed in shelters of the type shown in Figure 30, where clearances permit. Where climate conditions require, walls and doors may be added. A method of heating emergency vehicle engines shall be provided in those areas of extreme cold where engine starting is difficult. Structural materials will vary in accordance with local climatic conditions.

8.6.5 Lighting. Flood lighting shall be provided for security and to facilitate operation of the equipment. Use low pressure sodium fixtures for energy conservation. Provide dusk to dawn lighting controls. See MIL-HDBK 1004/4, Electrical Utilitzation Systems.

8.7 Towway. Towways for fixed- or rotary-wing aircraft are to be paved. If contemplated that aircraft may taxi under their own power on this area, taxiway criteria shall be used. Types of towways are based on aircraft to be towed: carrier aircraft, patrol and transport aircraft, and rotary-wing aircraft.

8.7.1 Pavement. Select pavement, rigid or flexible, whichever is more economically feasible. Since aircraft engines are not operated on towways, it is not necessary that the paving be resistant to jet or rotor blast.

8.7.2 Specific Requirements. For geometry and other criteria, see Table 18 and Figure 31. For lighting, refer to MIL-HDBK-1023/1.

8.7.3 Modification. When existing roads or other pavements are modified for use as towways, provide for necessary safety clearances, pavement strengthening (if required), and all other specific requirements set forth in Table 18 and Figure 31.

8.8 Ordnance Handling Pad. Where suitable aprons are unavailable, an isolated pad is required for cargo aircraft loading or off-loading explosives.

TABLE 17
Parking Area Requirements

Equipment	Area (sq yd)
Tow tractor	20
Refueling truck	47
Refueling trailer	70
Mobile electric power plant	12
Oxygen trailer	8
Utility jeep	11
Bomb truck	20
Bomb trailer	14
Industrial flat-bed truck	9
Industrial platform truck	9

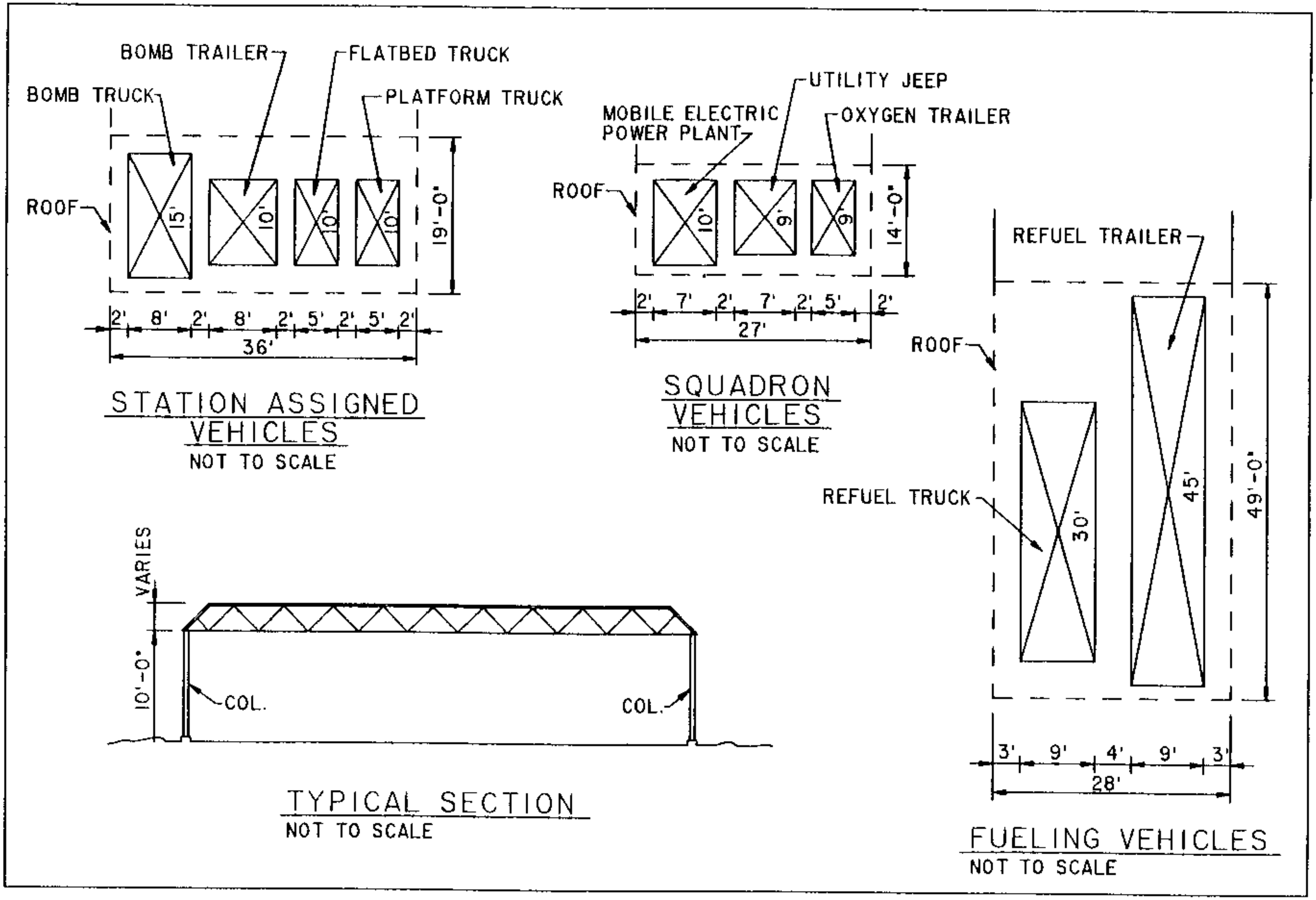
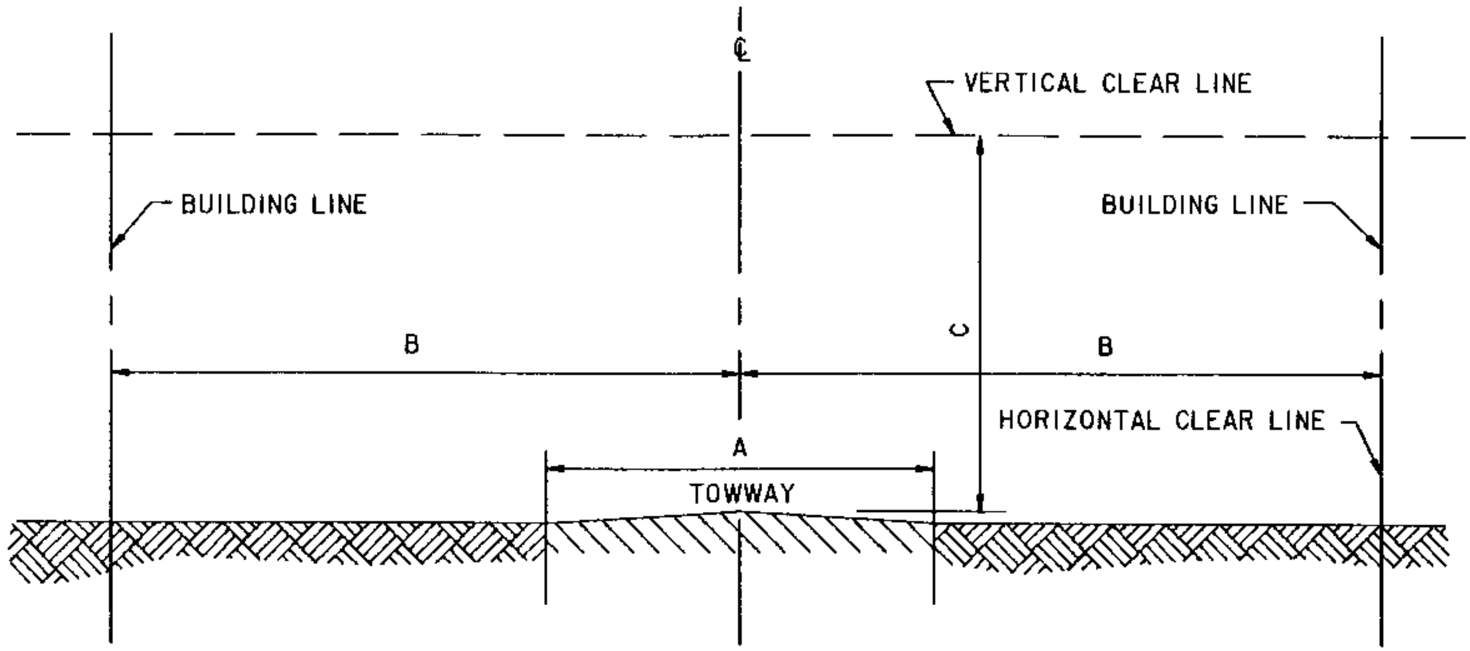


Figure 30
Typical Line Vehicle Shelters

TABLE 18
Design Criteria for Towways

Item	Type	Criteria
Load-bearing capacity		MIL-HDBK-1021/2/4. DM 21.03.
Width	Carrier	Minimum: 36 feet.
	Patrol and transport	Minimum: 40 feet.
	Rotary-Wing	Minimum: 35 feet.
Surface	Smoothness	Maximum irregularity shall be + 1/8 inch per 10 feet for rigid pavement and + 1/4 inch in 10 feet for flexible pavement in any direction.
Grades	Longitudinal	Maximum: 5%.
	Transverse	Minimum: -1%. Maximum: -l.5%.
Curves	Horizontal	Minimum radius: 150 feet.
	Vertical	Maximum rate of change of grade shall be 2.0% per 100 feet.
	Successive curves	Curves shall be separated by a minimum of 150 feet of tangent.
Vertical clearance	Carrier	Minimum: 25 feet.
	Patrol and transport	Minimum: 45 feet.
	Rotary-Wing	Minimum: 30 feet.
Lateral clearance	Carrier	50 feet on both sides of centerline.
	Patrol and transport	75 feet on both sides of centerline.
	Rotary-Wing	45 feet on both sides of centerline.
Fillets at intersections		Minimum radius: 100 feet.
Shoulders		Provide proper drainage and prevent erosion along edge of pavement.
Marking	Centerline	See NAVAIR 51-50AAA-2, mark as a taxiway.
Traffic lights		As required at intersections.



TYPICAL CROSS SECTION (SHOWING SAFETY CLEARANCES)

NOT TO SCALE

	DIMENSIONS		
TYPE OF AIRCRAFT	A	B	C
CARRIER	36'	50'	25'
PATROL AND TRANSPORT	40'	75'	45'
ROTARY WING	35'	45'	30'

Figure 31
Towway Criteria

8.8.1 Location. Pad shall be located at an isolated site near the landing end of the main runway. Airfield standard safety clearances must be complied with. Both road and taxiway access must be provided. For quantity and distance requirements for the type ordnance (explosive class) to be handled, see NAVFAC P-80. In some instances, barricades or natural barriers may be used to reduce the quantity-distance factor, according to the NAVSEA OP-5, Ammunition and Explosives Ashore, Volume 1, Safety Regulations for Handling, Storing, Production, Renovation and Shipping of Ammunition and Explosives Ashore and Volume 2, Storage Data.

8.8.2 Pavement. Provide same load-bearing capacity, surfacing, tiedowns, grades, and dimensions as for parking aprons for cargo aircraft. Overall size is determined by number of aircraft to be handled simultaneously. Grounding receptacles are not required, tiedowns are adequate for grounding.

8.8.3 Miscellaneous Items. Provide telephone service, fire hydrant, and lighting if required.

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REFERENCES

NOTE: Unless otherwise specified in the text, users of this handbook should utilize the latest revisions of the documents cited herein.

FEDERAL AND MILITARY SPECIFICATIONS AND STANDARDS AND MILITARY HANDBOOKS:

The following specifications, standards, and military handbooks form a part of this document to the extent specified herein. Unless otherwise indicated, copies are available from the Defense Printing Service, Standardization Document Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

SPECIFICATIONS

FEDERAL

SS-S-200	Sealant, Joint, Two Component, Jet-Blast Resistant, Cold Applied, for Portland Cement Concrete Pavement
SS-S-1614	Sealants, Joint, Jet Fuel Resistant, Hot-Applied, for Portland Cement and Tar Concrete Pavement

MILITARY

MIL-C-22992	Connector, Plugs and Receptacles, Electrical, Waterproof, Quick Disconnect, Heavy Duty Type; General Specification for

STANDARDS

MILITARY

MIL-STD-704	Aircraft Electric Power Characteristics
MIL-STD-90555	Connector, Receptacle, Electrical, Wall Mounting Class L (Power Source Receptacle)

MILITARY HANDBOOKS

MIL-HDBK-1004/4	Electrical Utilization Systems
MIL-HDBK-1005/3	Drainage Systems
MIL-HDBK-1005/8	Domestic Wastewater Control

REFERENCES (Continued)

MIL-HDBK-1005/9	Industrial Oily Wastewater Control
MIL-HDBK-1021/2	General Concepts for Airfield Pavement Design
MIL-HDBK-1021/4	Rigid Pavement Design for Airfields
MIL-HDBK-1023/1	Airfield Lighting
MIL-HDBK-1028/1	Airfield Maintenance Facilities

NAVY DESIGN MANUALS AND P-PUBLICATIONS

(Available from National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161, Attention: Defense Publications; phone 1-800-553-6847.)

DM-21.03	Flexible Pavement Design for Airfields
DM-22	Petroleum Fuel Facilities
P-80	Facility Planning Factor Criteria for Navy and Marine Corps Shore Installations
P-80.3	Appendix E, Airfield Safety Clearances
P-272	Definitive Designs for Naval Shore Facilities
P-970	Planning in the Noise Environment
P-971	Airfield and Heliport Planning Criteria

OTHER GOVERNMENT DOCUMENTS AND PUBLICATIONS:

The following Government documents and publications form a part of this document to the extent specified herein.

OPNAVINST 11010.36A	Air Installations Compatible Use Zone (AICUZ) Program

(Available from Commanding Officer, Naval Publications and Forms Center, 5901 Tabor Avenue, Philadelphia, PA 19120-5099.

References (Continued)

DEPARTMENT OF THE ARMY

ARMY TM-5-822-2/ AFM 88-7, CHAP 5	General Provisions and Geometric Designs for Roads, Streets, Walks, and Open Storage Areas

(Available from U.S. Army Publications Distribution Center, 1655 Woodson Road, St. Louis, MO 63114.)

FEDERAL AVIATION ADMINISTRATION (FAA)

FAA AC 150/5345-27	Specification for Wind Cone Assemblies

(FAA AC 150-5345-27 is available from the U.S. Department of Transportation, Utilization and Storage Section, M-443.2, Washington, DC 20590.)

NAVAL AIR SYSTEMS COMMAND

NAVAIR 51-50AAA-2	General Requirements for Shorebased Airfield Marking and Lighting

(NAVAIR 51-50AAA-2 is available from Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120; private organizations may purchase NAVAIR 51-50AAA-2 from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402)

NAVAL SEA SYSTEMS COMMAND

NAVSEA OP-5	Ammunition and Explosives Ashore, Volume 1, Safety Regulations for Handling, Storing,Production, Renovation and Shipping of Ammunition and Explosives Ashore
	Ammunition and Explosives Ashore, Volume 2, Storage Data

(NAVSEA OP-5, Volumes 1 and 2 are available from Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120; private organizations may purchase NAVSEA OP-5 from Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.)

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GLOSSARY

Aborted Takeoff. An unsuccessful takeoff operation due to power or other mechanical failures.

Airfield. An area on land used for the landing, servicing, and takeoff of aircraft.

Airfield Elevation. The official elevation of the airfield. The highest point of the usable landing area.

Airfield Pavement. Prepared surfaces of processed materials, laid on natural ground or on compacted earth fills, designed to carry aircraft wheel loads without exceeding the bearing capacity of the ground beneath the pavement.

Airfield Reference Point. A point located at the approximate centroid of the figure formed by joining the ends of runways as planned. The coordinates of the reference point shall be established and shows on the station drawings. For helicopter landing areas, it is the approximate center of the operational area.

Airport. Refers to a civilian or municipal landing field in naval usage.

Airspace. The space aboveground or water areas, which are or are not controlled, assigned, and/or designated.

Air Traffic. Aircraft in operation anywhere in the airspace and within that area of an airfield or airport normally used for the movement of aircraft.

Approach Control. A service established to control flights, operating under instrument flight rules (IFR), arriving at, departing from, and operating in the vicinity of airports by direct communication between approach control personnel and all aircraft operating under their control.

Approach Zone. That airspace beyond the runway end zone which is free from obstructions above a specified glide angle, and in which initial climbing subsequent to takeoff and final descent prior to landing take place.

Apron. A paved area to accommodate parked aircraft or provide access to hangars.

Arming and De-arming. The loading and unloading of missiles, rockets, and ammunition in aircraft.

Arresting Gear. The equipment incorporated in aircraft and in the landing area to limit the aircraft rollout distance.

Aviation Easement. A legal right obtained from a property owner to operate aircraft over that property and to restrict the height of any construction or growth on that property.

Beam Wind Component. The wind velocities perpendicular to the axis of the runway centerline used to measure the degree by which a runway pattern covers incident wind from the several directions.

GLOSSARY (Continued)

Blast Protective Area. An area protected by pavement construction at the ends of runways and taxiways against jet blast errosion.

Bond-Breaking Course. A separating course preventing bond development between an existing rigid pavement and rigid overlay pavement.

Caution Area. An area in which a visible hazard to aircraft in flight exists.

Clearway. An area free from obstruction at the upwind end of the takeoff runway in prolongation of the runway, covering an area 3,000 feet long by 500-feet wide.

Crash Strip. An area free of obstructions provided at the upwind end of takeoff runways, in prolongation of the overrun area.

Crosswind Runway. A secondary runway that is required when the primary runway direction provides less than 95 percent total wind coverage.

Displaced Threshold. A runway threshold that is not at the beginning of the full-strength runway pavement.

Dual Runway. Simultaneously usable runways that provide for traffic movement beyond the capacity of a single runway.

End Zone. A cleared and graded area extending beyond the end of the runway, capable of supporting an aircraft in event of overrun of the runway during an aborted takeoff or on landing when rollout extends beyond the runway.

Fixed-Wing Aircraft. An airplane having wings which do not normally move relative to the plane during flight. High-speed, swept-wing aircraft are considered to be fixed-wing aircraft.

Flight Path. The track of the aircraft in space during flight, including the glide path to touchdown on landing.

Full Stop Landing. The touchdown, rollout, and complete stopping of an aircraft to zero speed on runway paving.

Glide Angle. The acute angle between the descending flight path of an aircraft and a horizontal plane fixed relative to the runway.

Glide Path. The line to be followed by an aircraft as it descends from horizontal flight to point of landing. One of the three elements of an instrument landing system which furnishes vertical guidance for the correct descent to a runway.

Hardstand. A paved or stabilized parking area of sufficient strength and size to accommodate a designated number of aircraft or mobile equipment. It is connected to the runway or traffic area by a taxiway or towway.

Helicopter. A rotary-wing aircraft.

GLOSSARY (Continued)

High-Speed Taxiway Turnoff. A taxiway leading from a runway at an angle which allows landing aircraft to leave a runway at high speeds.

Instrument Runway. A runway which is provided with landing aids (such as high intensity runway lighting approach lights) and navigation aids for IFR (instrument flight rules) operations.

Intermediate Area. The area between runways and between runways and taxiways that is graded or cleared for operational safety.

Landing Area. The paved portion of a landing field for the safe landing and takeoff of aircraft.

Landing Field. Any area of land consisting of one or more landing strips, including the intermediate area, that is designed for the safe takeoff and landing of aircraft.

Landing Rollout. Distance covered in stopping the aircraft, when loaded to maximum landing weight, following touchdown using standard operation and braking procedures on a hard, dry-surfaced level runway with no wind.

Landing Strip. That portion of an airfield that includes the landing area, the end zones, and the shoulder areas. Also known as a flight strip.

Line Vehicle. Any vehicle used on the landing strip, such as a crash fire truck and tow tractor.

Magnetic North. The direction indicated by the north-seeking element of a magnetic compass when influenced only by the earth's magnetic field.

Magnetic Variation. The angular difference between magnetic north and true north.

Overlay (Also Overlay Pavement). A rigid or nonrigid pavement constructed on an existing pavement to increase its load-carrying capacity.

Overrun Area. An area the width of the runway plus paved shoulders extending from the end of the runway to the outer limit of the end zone. The portion which is a prolongation of the runway is the stabilized area.

Parallel Runway. Special form of dual runway in which the runway centerlines are parallel.

Power Check. The full power test of an aircraft engine while the aircraft is held stationary.

Rotary-Wing Aircraft. An airplane, such as a helicopter or autogiro, having wings that rotate about an axis, especially such an aircraft having wings that rotate about an approximately vertical axis.

Runway. A paved surface for the landing and takeoff of aircraft. This includes all-weather runways, instrument runways, and crosswind runways.

GLOSSARY (Continued)

Runway Exit. A taxiway pavement provided for turnoffs from the runway to a taxiway; may be either normal or high speed.

Runway Threshold. A line perpendicular to the runway centerline designating the beginning of that portion of a runway usable for landing.

Service Point. A receptacle, embedded in certain airfield pavements, containing outlets for utilities required to service aircraft.

Shoulder. An area provided for emergency use of aircraft and for dust and erosion control. Shoulders are provided for runways, taxiways, aprons, and compass roses. Some are paved, some are not.

Stabilized Soil. Soil treated in such a manner as to render its properties less affected by water or to increase its load-bearing capacity.

Taxiway. A paved surface over which aircraft can move under their own power.

Taxiway Turnoff. A taxiway leading from a runway to allow landing aircraft to exit and clear the runway after completing their initial landing roll.

Tiedown Anchor. A device, installed in certain airfield pavements, to which lines tying down an aircraft are secured and grounding is provided.

Towway. A paved surface over which aircraft can be towed.

True North. The geographic north; the direction of the geographic North Pole from a given point on the earth's surface.

Wind Direction. The direction from which the wind is blowing in reference to true north.

Wind Rose. A diagram showing the relative frequency and strength of the wind in correlation with a runway configuration and in reference to true north. It provides a graphic analysis to obtain the total wind coverage for any runway direction.

CUSTODIAN
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PREPARING ACVITIY
NAVY-YD

PROJECT NO.
FACR 0239